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# Receiving Grain Sorghum At Country Elevators In The Southwest

Agricultural Research Service

UNITED STATES DEPARTMENT OF AGRICULTURE

in cooperation with

TEXAS AGRICULTURAL EXPERIMENT STATION

# PREFACE

This report discusses the receiving of grain sorghum at commercial elevators. The work was conducted under the general supervision of Leo E. Holman, supervisory project leader. Owners of grain sorghum storages made their facilities available for the studies.

This research was conducted in cooperation with the Texas Agricultural Experiment Station.

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Washington, D.C. March 1965

# SUMMARY

Increased production of grain sorghum and a shorter harvesting period have resulted in more and larger deliveries of grain sorghum to elevators in the Southwest in a shorter period of time. Elevator operators can handle the larger volume more efficiently, without major changes in plant layout, by adopting the improved work practices and equipment suggested in this report. Recommendations also are made for improving the traffic pattern and arrangement of equipment at the elevator and the construction and location of the dump pit.

The study, based on elevators equipped with two elevating legs, either two single dump pits or one double pit, and one scale, showed that the weighing and testing of grain was the slowest of the operations performed in receiving truckloads of grain. Since two truckloads of grain could be handled at the dump pits at the same time, unloading grain and elevating it to storage bins averaged 4.24 minutes for two truckloads; the three methods of weighing and testing that were studied took from 4.78 to 6.40 minutes for two truckloads. Improvements suggested in weighing and testing reduced the time to 4.28 minutes for two truckloads.

The time required to unload trucks was controlled by the capacity of the elevating legs. In the elevators studied, each leg was operated at an average capacity of 185,000 pounds per hour. The elevating rate can be increased 15 percent or more if the legs and conveyors used in handling grain are properly adjusted and maintained.

A single-hook hoist for lifting trucks is easier to operate and more efficient than double-hook or cradle hoists, and trucks equipped with full-width tailgates are faster to unload than trucks with smaller endgates. Self-dumping trucks are the fastest and most economical to unload.

# Receiving Grain Sorghum at Country Elevators in the Southwest

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## BACKGROUND

During the late 1950's and early 1960's grain sorghum emerged as a major crop in Texas. Increased production necessitated the development of improved methods and equipment for planting and harvesting. Faster planting and harvesting methods have resulted in a shorter harvest season, and, as a consequence, carriers used to transport grain from the field to the elevator have increased in size and number in the same relatively short time. Grain elevators could not change quite as rapidly; modification of facilities can be rather expensive. Elevator operators, therefore, have become increasingly interested in improved methods and equipment for handling larger volumes of grain sorghum in shorter periods of time.

The objectives of this study were to (1) determine the time and labor required and the cost of receiving grain sorghum, and (2) increase the rate of receiving by improving handling methods, equipment, or facility layouts.

Commercial grain storage firms in Texas were visited, to formulate a basis as to what equipment and methods should be studied. Facility layouts, equipment, and methods used for receiving were observed. Data were compiled on the different ways operations in the receiving cycle were performed. During subsequent harvest seasons, motion and time studies were made at selected locations. In the time and motion studies, handling equipment speeds, power consumption, distance grain moved within the storage, and numerous other items were observed, measured, and recorded. Those data were analyzed, and the base time[2] was determined for specific jobs using different methods and equipment. The base times shown in table 7, appendix, represent the average time compiled from a number of observations made at several elevators during the harvest season. The report is based on a facility with two 11- by 7-inch bucket elevators, two single dump pits or one double pit, and one scale, and receiving 2,300 truckloads of grain sorghum per year.

Labor costs are based on productive time required to perform the receiving operation, plus the wait (unproductive) time inherent in the method. A number of activity charts are included in the report to show the productive and unproductive labor and the elements of work involved in the receiving operations, both for the observed methods and the suggested improved methods. The unproductive labor (wait time) is shaded to emphasize when and where such wait time occurs. This is the time the warehouseman is interested in eliminating to cut down labor costs or to improve his receiving operations.

Equipment costs were obtained from dealers, equipment manufacturers, insurance companies, and elevator operators. These costs are grouped under two main categories: Ownership costs, considered relatively constant from year to year, and operating costs, which are variable, as they reflect the hours of use of the equipment.

Labor rates vary from firm to firm, but the average wage for the scale operator and

[1] Mr. Slay has resigned from the U.S. Department of Agriculture.

[2] See Definition of Terms in appendix.

the person normally in charge of pit operations during the study was $1.50 per hour, and for all helpers, $1.20 per hour. An average of $1.25 per hour for all workers is used in computations in this report.

## METHODS AND EQUIPMENT OBSERVED

Grain sorghum, like most agricultural products, requires much handling before it reaches the user. "Receiving," one of the most important phases of the handling process, occurs when the grain arrives at the elevator from the field. Several types of carriers are used for transporting grain. Farm trucks, often called bobtail trucks, are most often used for transporting grain from field to elevator, but tractor-trailers are being used at an increasing rate. Use of pickup trucks and farm trailers is diminishing in those areas where custom combines are used.

The work performed at elevators in receiving truckloads of grain sorghum is grouped into two general operations in this report: (1) Weighing and testing the grain (for moisture content or test weight), and (2) unloading the grain from trucks into the elevator dump pit and elevating the grain to storage bins.

In the methods of receiving described here, no attempt has been made to follow procedures used by a particular firm. Some operators may find the sequence and work performance reported very similar to the sequence and work performance used at their elevators, and others may find that only some of the work elements are identical.

### Weighing and Testing

Trucks delivering grain sorghum are weighed before and after unloading, at a scale located some distance from the elevator dump pit. A small office (scale house) is beside the scale. Grain is tested either before the loaded trucks reach the scale or while the trucks are being weighed.

Two general classes of scales are used by industry for weighing trucks--the automatic balancing scale and the calibrated beam scale.

One type of automatic balancing scale has a dial indicator, and most of those used in the grain sorghum industry are equipped with a printing mechanism that records the weight on the scale ticket. This scale is fast, and the dial is easily observed by customers.

A second type of automatic balancing scale is the viewplate type. It is a fast operating scale, but is not widely used perhaps because the scale requires manual recording of weights and the weight indicator cannot be read at a distance. These two restrictions are important. Printed weights eliminate chance of human error, and customers like to see the weight indicator. This scale was used at only a few elevators during the time this study was made.

The calibrated beam scale, manually balanced, is used extensively in the industry. Several attachments are available to reduce the time required to weigh with this scale, but the scales observed were equipped only with the over and under indicator. This scale is equipped to print weights, but manual balancing is time-consuming.

The dial scale is used in all charts showing the weighing operation in this report.

When a loaded truck arrives at the scale, the scale operator weighs the truck and records on the scale ticket the name of the grain owner, the date, and, if these tests are made, the moisture content and test weight of the grain. The scale operator puts the ticket aside, in order, so the correct one is available when the same truck returns to the scale after unloading the grain. (If the elevator has only one dump pit, the tickets are stacked, with the ticket for the last-weighed loaded truck placed on the bottom of the stack. If the elevator has more than one dump pit, the tickets are placed side by side on the scale desk, with the ticket for the last-weighed loaded truck always on the left.)

When the empty truck returns to the scale, it usually takes precedence for weighing over

a loaded truck. The scale operator weighs the empty truck and records the net weight of the grain. The truckdriver dismounts and walks to the scale-house window or into the scale house to receive his copy of the ticket.

The extent of testing done at a particular elevator is determined by the harvest rush and by individual operating practices. It rarely exceeds a moisture test and a test-weight determination. A probe, or trier, and a sample container are used in collecting one to three probes of grain for these tests.

During the study, a moisture determination was made at all elevators on every load of grain received. Moisture tests were made to compute drying and shrinkage charges and to provide information for separating grain according to high or low moisture. This separation usually occurred at a moisture content of 15 percent. In storages that had more than one dump pit, the high-moisture grain was sent to one pit and the low-moisture grain to another. Where there was only one dump pit and the grain was separated according to moisture content, the pit had to be emptied before grain of other moisture levels could be dumped.

A worker other than the scale operator collected a sample of grain and ran the moisture test. When the grain was separated according to moisture content, this worker or the scale operator prepared a ticket showing the moisture content and truckdrivers were given the tickets to give to the workers at the dump pit. Otherwise, the scale operator recorded the moisture content on the scale ticket instead of preparing a separate ticket.

The equipment used to determine grain moisture consisted of a gram scale and a dielectric moisture tester similar to the one shown in figure 1. A sample of 150 grams was used in the tester studied.

Many storage operators did not make adjustments in moisture determinations to compensate for temperature variations in the grain. Most of them made only periodic checks of the temperature of the grain during the day, as the grain received was all near the same temperature, and a uniform correction was applied. At elevators where temperature readings were made, the thermometers were seldom left in the grain long enough for the thermometer to arrive at the correct reading.

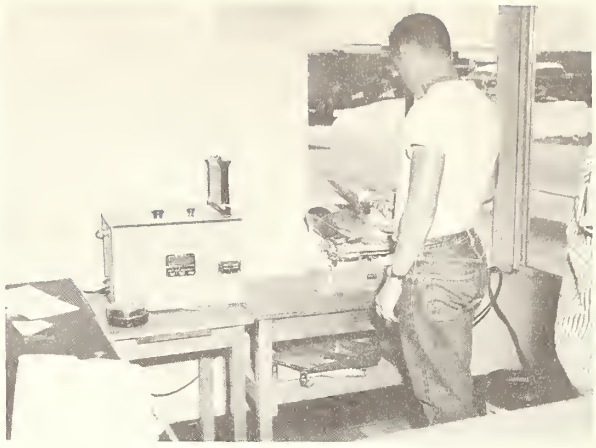

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Figure 1.--Dielectric moisture tester at left and gram scale at right.

Test weight of the grain was determined at most elevators only during the early part of the harvest season. If the grain met grade standard requirements, testing was discontinued until grain from a new field was received. Then one or two checks were made for test weight. When grain of low test weight was received, it was usually sent to a separate dump pit, and testing of each truckload was continued until the grain met grade standard requirements. The equipment required for determining test weight consisted of a balance scale and a grain cup of specified volume.

Two principal methods used to weigh and test a truckload of grain were studied. In one method the testing was performed in conjunction with the weighing; this method is referred to as the combined method. In the second method, testing was performed independently of weighing; this is referred to as the independent method.

### Combined Method

Combined weighing and testing was most commonly used in the sorghum industry in the

Southwest during the study period. While the scale operator weighs the loaded truck, a second man, working from a dock beside the truck scale, collects a grain sample, enters the scale house, and runs the moisture test. Docks range from 38 to 46 inches high but most are 40 to 42 inches high.

The truckdriver generally goes to the scale house to give the necessary information to the scale operator while the loaded truck is being weighed. The scale operator makes out scale and moisture tickets and gives the moisture ticket to the driver. When the driver returns to have the empty truck weighed, he goes to the scale-house window to get the completed scale ticket.

When test weight of the grain must be determined, the moisture-test operator collects a grain sample and makes the moisture test, but a third worker (test-weight operator) makes the test-weight determination.

### Independent Methods

Independent weighing and testing is done in two ways. In the first, grain is tested at a sampling and testing station separate from the scale house, and trucks then proceed to the scale to be weighed. The dock at the test station is high enough so the worker can step directly from it onto the truck. At the test station, one man collects the grain sample and makes the moisture determination. A two-man crew is used at the test station if test-weight determinations are required. When grain is tested in this manner, a separate set of records on every truck or a means of communicating with the scale house is necessary. Usually trucks are numbered and logged at the test station and a moisture ticket is given to the driver. The driver shows the scaleman the ticket when he arrives at the scale-house window. The scale operator then weighs the truck and prepares the scale ticket. When the truckdriver returns to the scale to have the empty truck weighed, he goes to the scale house to get his copy of the scale ticket.

In the second type of independent weighing and testing, a worker obtains samples of grain from trucks while they are waiting to reach the scale and brings the grain samples back to the scale house for testing. The normal procedure is for the worker to walk from the scale house to the line of trucks, use a ladder to board the truck, collect the sample, number the truck and a moisture ticket, and place the ticket in the grain-sample container. He usually takes samples from at least two trucks before returning to the scale house. When test-weight determinations are not required, this worker makes the moisture test, records the moisture on the ticket, and places the ticket on the scale operator's desk. When test-weight determinations are required, a second worker (test operator) makes both the moisture and test-weight determinations and records them on the moisture ticket; the first worker collects the grain samples.

When a loaded truck drives onto the scale, the scale operator selects the moisture ticket with the number matching that of the truck and records the moisture content and test weight on the scale ticket. The truckdriver goes to the scale house to get the moisture ticket and, after the empty truck is weighed, picks up his copy of the scale ticket.

### Comparison

Of the three methods studied, independent weighing and testing at separate facilities took the least time and required the least labor. (table 1). Activity charts showing the sequence of work elements for each of the methods are in the section, "Labor Requirements for Some of the Observed Methods," as figures 14, 15, 16, 17, and 18.

## Unloading and Elevating Grain

Grain is unloaded from trucks into the elevator dump pits and elevated from the dump pits to storage bins. At all elevators studied, the capacity of the elevating leg determined the time required to unload a truckload of grain. Trucks could be unloaded no faster than the grain could be moved from the dump pit by the bucket elevator.

Table 1.--Observed methods of weighing and testing: Elapsed time and labor requirements per truckload of grain sorghum

| Work performed, crew size, and method | Elapsed time per operation | | Wait time between operations[1] | Total elapsed time | Labor required |
|---|---|---|---|---|---|
| | Weighing | Testing | | | |
| Weighing loaded and empty trucks and making moisture test, 2-man crew: | | | | | |
| | Minutes | Minutes | Minutes | Minutes | Man-minutes |
| Independent weighing and testing at separate facilities | 2.39 | 1.97 | 0.42 | 2.39 | 4.78 |
| Independent weighing and testing at scale house facilities | 2.39 | [2] 2.56 | .17 | 2.56 | 5.12 |
| Combined weighing and testing | -- | -- | -- | 3.20 | 6.40 |
| Weighing loaded and empty trucks and making moisture and test-weight determinations, 3-man crew: | | | | | |
| Independent weighing and testing at separate facilities | 2.39 | 1.94 | .45 | 2.39 | 7.17 |
| Independent weighing and testing at scale house facilities | 2.39 | [2] .52 | .87 | 2.39 | 7.17 |
| Combined weighing and testing | -- | -- | -- | 2.85 | 8.55 |

[1] Wait time between operations is shown only for the independent methods of weighing and testing, since the weighing and testing operations are performed in conjunction with one another in the combined method. Some wait time occurs for the workers during operations for all methods; see figures 14, 15, 16, 17, and 18.

[2] Normally two trucks are tested per cycle as shown in figures 16 and 17; time shown in one-half that required for two trucks.

The average handling capacity of the bucket elevators studied was about 185,000 pounds per hour, which is below the rated capacity prescribed by manufacturers for 11- by 7-inch bucket elevators. Generally, the legs were not loaded to the rated capacity because of fear of chokedown, or because capacity was limited by the attendant handling equipment--horizontal conveyors, dump pits, dump pit gates, and so forth.

The average truckload of grain weighed 13,000 pounds (the range was 9,000 to 16,000 pounds), and the average elapsed time to unload and elevate one truckload with one leg was 4.24 minutes.

Two basic layouts of dump pits were used in the grain sorghum industry during the study period. One was a single-pit layout. If an elevator had more than one single-pit

layout, they were separated from each other by sufficient distance that separate crews (two or three men each) were required at each pit. The second layout was a double pit (fig. 2). In a double-pit layout, one 3-man crew performed the labor for both pits. Dump pit capacity ranged from 30,000 to 40,000 pounds.

Most of the equipment used to raise trucks or truck beds for unloading falls into three main categories. The first and most commonly used was the cradle hoist; trucks are tilted with their front wheels in the cradle and rear wheels on the ground (fig. 3A). The second was the platform hoist, which holds and tilts the entire truck. The third was the self-dumping truck with its own built-in hoisting system to elevate the front end of the truck bed.

The self-dumping truck (fig. 3B) is the simplest and quickest for unloading grain; one man and the truckdriver can perform the dumping operation. A cradle hoist is fairly flexible because the hoisting mechanism is mounted on a track and can accommodate any length of farm truck. The main disadvantage is the difficulty encountered in starting engines of trucks that are hoisted in this manner. Other disadvantages are that the cradle is often pushed along in front of the truck wheels and that drivers often have difficulty positioning the front wheels of the truck properly.

Figure 3C shows another method in limited use during the study in which two cables are used to raise the truck bed. With this arrangement the pitman sets one hook on one side

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Figure 2.--In a double-pit layout, the dump pits are side by side.

of the bed and the driver may set the hook on the opposite side.

The platform hoist, hydraulically operated (fig. 3D), is perhaps the most versatile of all methods of raising trucks. Any size or type of truck can be raised and emptied in about the same amount of time. Tractor-trailers can be unloaded in much less time by this method than by other common methods.

Although the elapsed time to unload and elevate each truckload was the same no matter which type of equipment was used to hoist trucks or whether the elevator had single or double dump pits, elevators with double-pit layouts needed less labor to do the same work. Three men could unload and elevate grain at a double pit, but four or six men (two or three at each pit) were necessary at two single pits (figs. 24 and 25 in appendix).

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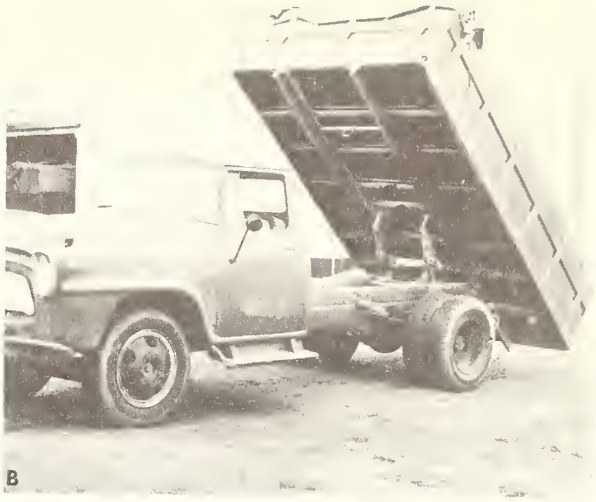

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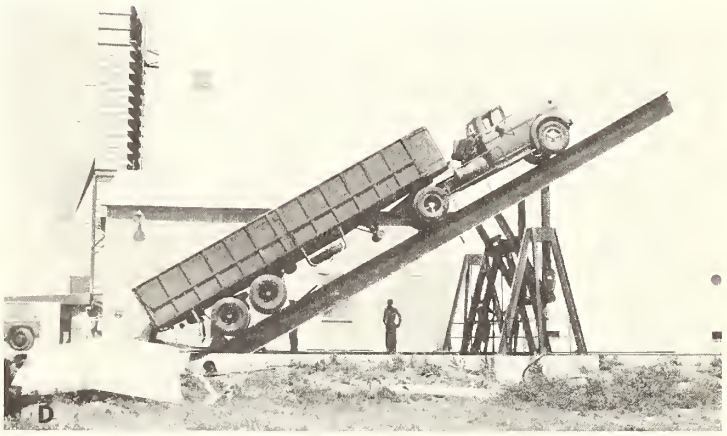

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Figure 3.--(A) Cradle hoist; (B) self-dumping truck; (C) hook-hoist with two hooks; and (D) platform hoist.

## The Receiving Cycle--Time, Requirements, and Costs

Most of the elevators studied used one truck scale and two dump pits (either two single pits or one double pit). Since two trucks could be handled at the same time at two pits, time and labor requirements are based on handling two truckloads at a time at the dump pits and two truckloads in sequence at the scale (table 2).

Table 2.--Observed methods: Labor requirements and elapsed time for receiving two truckloads of grain sorghum

[When the grain is tested only for moisture content]

| Weighing and testing method, type of pit layout, and crew size at pits | Total crew[1] | Elapsed time for-- | | Wait time for dump pit crew | Total elapsed time | Total labor required |
|---|---|---|---|---|---|---|
| | | Weighing and testing | Unloading and elevating | | | |
| | No. | Minutes | Minutes | Minutes | Minutes | Man-minutes |
| Independent weighing and testing at separate facilities, unloading and elevating at-- | | | | | | |
| One double pit with 3 men | 5 | [2] 4.78 | 4.24 | 0.54 | 4.78 | 23.90 |
| Two single pits with 4 men | 6 | 4.78 | 4.24 | .54 | 4.78 | 28.68 |
| Two single pits with 6 men | 8 | 4.78 | 4.24 | .54 | 4.78 | 38.24 |
| Independent weighing and testing at scale house, unloading and elevating at-- | | | | | | |
| One double pit with 3 men | 5 | [3] 5.12 | 4.24 | .88 | 5.12 | 25.60 |
| Two single pits with 4 men | 6 | 5.12 | 4.24 | .88 | 5.12 | 30.72 |
| Two single pits with 6 men | 8 | 5.12 | 4.24 | .88 | 5.12 | 40.96 |
| Combined weighing and testing, unloading and elevating at-- | | | | | | |
| One double pit with 3 men | 5 | [4] 6.40 | 4.24 | 2.16 | 6.40 | 32.00 |
| Two single pits with 4 men | 6 | 6.40 | 4.24 | 2.16 | 6.40 | 38.40 |
| Two single pits with 6 men | 8 | 6.40 | 4.24 | 2.16 | 6.40 | 51.20 |

[1] In each case, the weighing and testing crew is two men.
[2] Figure 18.
[3] Figure 16.
[4] Figure 14.

The shortest elapsed time and lowest labor requirements for the receiving cycle occurred when the grain was weighed and tested (moisture test only) at separate facilities and when three men unloaded the trucks and elevated the grain at a double-pit layout.

Each method of weighing and testing took longer than unloading and elevating and therefore determined the elapsed time and labor requirements for the entire receiving cycle.

Labor and equipment costs for receiving two truckloads of grain sorghum are given in table 3. The total cost for two truckloads is affected most by the type of equipment used to hoist trucks. Trucks with their own hoisting equipment (self-dumping trucks) are, of course, the cheapest to receive, and cradle hoists are less expensive to use than platform hoists.

Because of the smaller crew needed, the double pit has lower total costs per two truckloads in each case than two single pits.

Total costs per two truckloads are highest, for each type of pit layout and hoisting equipment, when the combined method of weighing and testing is used.

## IMPROVING RECEIVING OPERATIONS

With the fastest receiving methods observed, an elevator equipped with two elevating legs, two pits, and one scale could handle about 25 trucks an hour (two each 4.78 minutes). Using the next quickest methods, the elevator could receive 23 to 24 trucks an hour, and with the slowest, about 18 trucks an hour. If the unloading and elevating operation controlled the speed of receiving, rather than the weighing and testing operation, the number of trucks handled in an hour could reach 28, at the capacity at which elevating legs were operated. Improvements are suggested for the weighing and testing operation that bring the elapsed time of this operation into balance with that of unloading and elevating. Recommendations are also made for increasing the capacity of elevating legs, and reducing the labor required for weighing and testing and for unloading trucks.

### Speeding Up Weighing and Testing

Although the combined method of weighing and testing was the slowest of the three methods observed, it offered the best possibility for improvement, because the time of two men working together could be better arranged than two working separately. Moreover, the combined method is that most commonly used in the industry.

Improvements in this operation (weighing and making moisture test only) can be brought about by: (1) Using a moisture tester that does not require weighing the grain sample and does not need to be cleaned after each sample is tested (the grain passes through the tester into a container below). A moisture reading can be made in 1/2 minute with this type of tester, whereas testers presently used that require weighing of the grain and cleaning after each sample take a full minute. Use of other new and improved types of testers, which do require weighing of the grain sample, would also speed up the moisture test because these testers provide for fast weighing. If a fast moisture tester is used, the scale operator can weigh the truck in the same time that the moisture test is being made.

(2) Having the truckdriver remain in the truck with the truck engine running both times the truck is weighed. The test operator will have time to walk to the truck and hand the driver his copies of both the moisture and scale tickets. This reduces the time the scale and test operators waited for drivers to start their truck engines and clear the scale.

Figure 4 shows the sequence of work for weighing and testing (moisture test only) with these improvements.

The test operator, on the scale-house dock, helps direct truck traffic. The scale operator starts to prepare the scale ticket as soon as the loaded truck moves onto the scale.

As soon as the test operator has collected and tested the grain sample, he reports to the scale operator, then makes out a moisture ticket and takes it to the truckdriver.

Table 3.--Observed methods: Labor and equipment costs for receiving two truckloads of grain sorghum

| Weighing and testing method, type of pit layout, and testing performed | Crew size[1] | Elapsed time | Labor cost[2] | Equipment cost when hoisting is by--[3] | | | Total cost when hoisting is by-- | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Self-dump | Cradle | Platform | Self-dump | Cradle | Platform |
| Independent weighing and testing at separate facilities, and unloading and elevating at-- | | Minutes | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| One double pit: | | | | | | | | | |
| Moisture test only..... | 5 | 4.78 | 0.50 | 3.08 | 3.46 | 5.54 | 3.58 | 3.96 | 6.04 |
| Moisture and test-weight... | 6 | 4.78 | .60 | 3.08 | 3.46 | 5.54 | 3.68 | 4.06 | 6.14 |
| Two single pits: | | | | | | | | | |
| Moisture test only..... | 6 | 4.78 | .60 | 3.08 | 3.46 | 5.54 | 3.68 | 4.06 | 6.14 |
| Moisture and test-weight... | 7 | 4.78 | .69 | 3.08 | 3.46 | 5.54 | 3.77 | 4.15 | 6.23 |
| Independent weighing and testing at scale house, and unloading and elevating at-- | | | | | | | | | |
| One double pit: | | | | | | | | | |
| Moisture test only..... | 5 | 5.12 | .53 | 3.08 | 3.46 | 5.54 | 3.61 | 3.99 | 6.07 |
| Moisture and test-weight... | 6 | 4.78 | .60 | 3.08 | 3.46 | 5.54 | 3.68 | 4.06 | 6.14 |
| Two single pits: | | | | | | | | | |
| Moisture test only..... | 6 | 5.12 | .63 | 3.08 | 3.46 | 5.54 | 3.71 | 4.09 | 6.17 |
| Moisture and test-weight... | 7 | 4.78 | .69 | 3.08 | 3.46 | 5.54 | 3.77 | 4.15 | 6.23 |
| Combined weighing and testing, and unloading and elevating at-- | | | | | | | | | |
| One double pit: | | | | | | | | | |
| Moisture test only..... | 5 | 6.40 | .67 | 3.08 | 3.46 | 5.54 | 3.75 | 4.13 | 6.21 |
| Moisture and test-weight... | 6 | 5.70 | .71 | 3.08 | 3.46 | 5.54 | 3.79 | 4.17 | 6.25 |
| Two single pits: | | | | | | | | | |
| Moisture test only..... | 6 | 6.40 | .80 | 3.08 | 3.46 | 5.54 | 3.88 | 4.26 | 6.34 |
| Moisture and test-weight... | 7 | 5.70 | .83 | 3.08 | 3.46 | 5.54 | 3.91 | 4.29 | 6.37 |

[1] A two-man crew is used for weighing and testing when the moisture test only is made; a three-man crew, when both moisture and test-weight determinations are made. A three-man crew is used at a double pit and a four-man crew at two single pits (two men per pit).

[2] An average labor rate of $1.25 per hour is used.

[3] Equipment costs are based on appendix table 6.

## IMPROVED METHOD

*Combined Weighing and Testing, 2-Man Crew*

**Moisture Test Only**

| | TRUCK DRIVER | MINUTES | SCALE OPERATOR | MINUTES | TEST OPERATOR | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 | DRIVES LOADED TRUCK ONTO SCALE | 0.12 | STARTS TICKET FOR LOADED TRUCK | 0.36 | DIRECTS TRAFFIC | 0.12 |
| 0.20 | DISMOUNTS FROM TRUCK, WALKS TO WINDOW AND GIVES INFORMATION | 0.23 | | | COLLECTS GRAIN SAMPLE | 0.40 |
| 0.30 | | | | | | |
| 0.40 | | | | | | |
| 0.50 | BOARDS TRUCK | 0.14 | WEIGHS LOADED TRUCK | 0.20 | | |
| 0.60 | WAITS IN TRUCK WITH ENGINE RUNNING | 0.51 | PRINTS TICKET | 0.04 | TRANSPORTS SAMPLE(18') | 0.13 |
| 0.70 | | | COMPLETES TICKET FOR LOADED TRUCK | 0.36 | DETERMINES MOISTURE CONTENT AND REPORTS TO SCALE OPERATOR | 0.26 |
| 0.80 | | | | | | |
| 0.90 | | | | | | |
| 1.00 | | | | | RECORDS MOISTURE | 0.05 |
| 1.10 | RECEIVES REPORT | 0.07 | LAYS ASIDE TICKET FOR LOADED TRUCK | 0.08 | WALKS TO TRUCK AND HANDS MOISTURE REPORT TO DRIVER | 0.11 |
| 1.20 | DRIVES AWAY | 0.10 | INSERTS TICKET FOR EMPTY TRUCK IN SCALE | 0.11 | RETURNS TO DOCK | 0.07 |
| 1.30 | DRIVES EMPTY TRUCK ONTO SCALE | 0.11 | WEIGHS EMPTY TRUCK | 0.20 | WAITS | 0.72 |
| 1.40 | WAITS IN TRUCK WITH ENGINE RUNNING | 0.69 | PRINTS TICKET | 0.04 | | |
| 1.50 | | | WRITES TICKET FOR EMPTY TRUCK | 0.47 | | |
| 1.60 | | | | | | |
| 1.70 | | | | | | |
| 1.80 | | | | | | |
| 1.90 | | | | | | |
| 2.00 | | | HANDS SCALE TICKET TO TEST OPERATOR | 0.07 | RECEIVES SCALE TICKET | 0.07 |
| 2.10 | RECEIVES TICKET | 0.07 | LAYS TICKET COPY ASIDE | 0.08 | WALKS TO TRUCK, HANDS TICKET TO DRIVER | 0.11 |
| 2.20 | DRIVES AWAY | 0.10 | WAITS | 0.13 | MOUNTS DOCK | 0.06 |
| | | | | | WAITS | 0.04 |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | 2.01 | | 1.38 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | 0.13 | | 0.76 |
| | ELAPSED TIME (MINUTES) | | 2.14 | | | |

Figure 4.

The test operator returns to the scale-house window as an empty truck is driven onto the scale. When the scale operator completes the scale ticket, the test operator takes it to the truckdriver.

The elapsed time per truckload is 2.14 minutes, whereas the time observed during the study was 3.20 minutes for combined weighing and testing and 2.39 minutes for the fastest independent method. The test operator is still idle about 35 percent of the time (fig. 4, shaded area).

Use of these improvements would balance the elapsed time to weigh and test two truckloads (4.28 minutes) with that for unloading and elevating two truckloads (4.24 minutes), and about 28 truckloads of grain sorghum could be received in an hour.

The elapsed time and number of workers required for this operation when test-weight determinations are made depend on whether or not grain of low test weight is separated from other grain at the dump pits. In the observed methods of weighing and testing, test-weight determinations were made before the loaded truck proceeded to the dump pits. This would add 1/2 minute to the elapsed time for the improved weighing and testing operation (total time per truck would be 2.64 minutes). Unless the separation of low test-weight grain is necessary, however, the test-weight determination could be made by the moisture-test operator while the empty trucks were being weighed, with no increase in time. If low test-weight grain is to be separated at the dump pits, a third worker could make the test while the loaded truck was being weighed, and the elapsed time would remain at 2.14 minutes per truck. This worker would be idle about 73 percent of the time.

## Making Unloading and Elevating More Efficient

### Elevating

The study showed that the capacity of the elevating and conveying equipment generally governs the elapsed time required for unloading truckloads of grain. Elevating rates can often be increased 15 percent or more if improvements are made in this equipment. To make such improvements an operator can:

1. Check the manufacturer's recommendations on cup spacing, belt speed, power requirements, and pulley size and conform to these specifications for putting the leg in its best operating condition unless experience has dictated a better operation.
2. Keep leg and conveyor belts properly adjusted.
3. Keep discharge baffles in the throat of the downleg in good condition and properly spaced for the grain most often handled.
4. Install an ammeter in the motor circuit of the leg to assure the correct loading rate.

It is sometimes possible to replace cups on a leg belt with cups of higher capacity spaced closer together. Before doing this it is necessary to determine if the belt will have sufficient strength for the added load. It may be necessary to install a new belt. The bearings in the head pulley and boot pulley must also be checked, as well as the capacities of motors and drives, before such changes are made.

The installation of a larger leg, or an additional leg, may be desirable if the increased receiving capacity can be justified by an anticipated increased profit due to the increased volume, or if such a change improves the efficiency of other equipment used in the handling operations, such as a small pit.

Ball bearings have a longer life at high speeds than wood or babbitt bearings and will reduce the required horsepower.

A good maintenance program is a must for trouble-free operation at any elevator. During the harvest season when the equipment is used the most, employees should grease and oil equipment during the lax morning hours or at other convenient times. The foreman should schedule the maintenance. A complete check on the operating condition of all equipment should be made annually.

Grain is moved from the dump pit either by gravity or conveyor to the bucket elevators which move the grain into storage bins. The gravity-feed pit with a discharge gate opening directly into the boot of the bucket elevator requires no expenditure for extra conveyors. However, trashy or high-moisture grain has a tendency to bridge (form an arch over the opening) if the pit lacks adequate wall slope.

If grain is removed from the pit by conveyor, the discharge gate should be located in the center of the pit. This arrangement allows the maximum wall slope on all sides and construction of a larger pit within a specified area, and it reduces the problem of bridging.

Screw and belt conveyors are commonly used for horizontal movement of grain in the Southwest. Drag-type conveyors and pneumatic conveyors are less popular. However, new designs of drag-type conveyors, which move the grain through a trough similar to those on screw conveyors, are being used more. Like the screw conveyor, they require less space, are easier to install, and have a lower initial cost than the belt conveyors. With the drag-type or screw conveyor the grain moves through an enclosed tube or tunnel, and less dust escapes during the movement of grain. The drag-type conveyor is rated to move more grain with less power than screw conveyors.

The belt conveyor costs less to operate than screw or drag conveyors and provides for visual inspection of the grain as it is being moved.

Regardless of the choice of conveyors the capacity of the conveyor should be equal to that of the elevating equipment, conveyors, pits, gates, and other equipment used in the same operation.

## Unloading

The labor required to unload trucks is affected by the type of hoisting equipment used and the tailgate arrangement on the truck. These factors can also affect the time required for the unloading and elevating operation (if elevating capacity is not the limiting factor). The elapsed times and labor requirements shown in this section assume the grain can be elevated as fast as it is unloaded.

Generally, the elevator owner has little control over the type of trucks delivering grain to his elevator and must supply equipment and labor to receive all common types being used. However, he may be able to influence owners to use certain combinations of trucks and tailgates because of the advantage both to himself and the truck owner.

Three types of tailgates were used on trucks hauling grain sorghum to elevators during the study: (1) Full-width, full-height gates, hinged at the top so that they swing out at the bottom (fig. 5A).[3] (2) Folding full-width gates, about 10 inches high, which must be removed and laid aside during unloading (fig. 5B). (3) Sliding or hinged gates that are smaller than either of the other two (fig. 5C). These small gates can be opened in about the same time as the other two types, but grain must be shoveled from the corners of the truck bed to complete emptying.

The type of latch on the tailgate has a decided effect on the time required to open and close the gate. Hinged, full-width gates, equipped with lever latches (fig. 5A) can be opened and closed faster than any other combination of gate and latch studied. They also require the least amount of effort to open and close. The same type of gate with peg latches (fig. 5D) takes longer than the folding full-width gate (fig. 5B), but the folding gate requires more effort because it has to be put aside during the dumping operation and then replaced. Table 4 gives the average productive time

Table 4.--Productive time required for 1 man to open and close full-width tailgates on trucks

| Time item | Hinged tailgate | | Folding tailgate |
|---|---|---|---|
| | Lever latch | Peg latch (3 pegs) | |
| | Man-minutes | Man-minutes | Man-minutes |
| Open tailgate..... | 0.12 | 0.46 | 0.23 |
| Lay tailgate aside..... | -- | -- | .11 |
| Pick up tailgate.. | -- | -- | .12 |
| Close tailgate.... | .14 | .35 | .29 |
| Total..... | 0.26 | 0.81 | 0.75 |

[3] A similar tailgate, which may be inexpensively and easily built, is shown in "Receiving Rice from Farm Trucks at Commercial Dryers," by W.O. Slay and Reed S. Hutchison, U.S. Dept. Agr. Mktg. Res. Rpt. 499. This tailgate is described in more detail in "A Complete-Opening Endgate for Faster Unloading of Grain from Farm Trucks," by Albert H. Graves, U.S. Dept. Agr. Mktg. Bul. 23.

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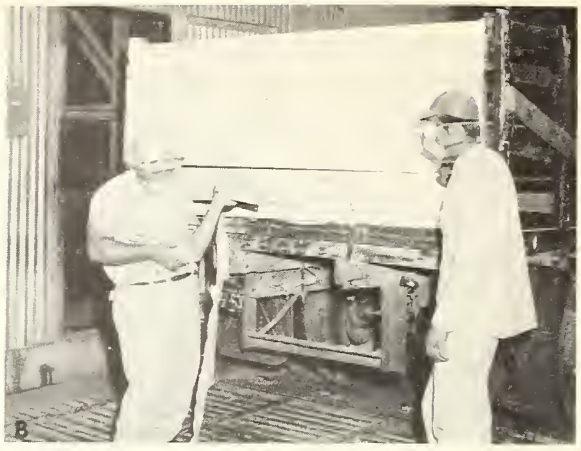


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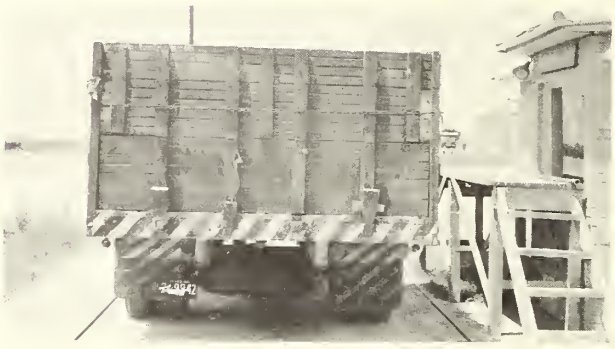

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Figure 5.--(A) Full-width, full-height tailgate with lever latch. (B) Folding tailgate. Gate is removed and laid aside while grain is unloaded from the truck. (C) A small hinged tailgate on truck emptying into a single pit. (D) Full-width tailgate with peg latch.

required to open and close the two types of full-width gates (hinged and folding).

The self-dumping truck is the fastest and, from the standpoint of the grain elevator operator, the most economical for dumping grain into the pit. If this were the only type of truck received, the elevator would not need a hoist mechanism nor would more than one man be required at each pit. Figure 6 shows the labor required and sequence of operations for one man to unload a self-dump truck with a full-width tailgate and lever latch. The possible elapsed time per truck is 1.61 minutes, much shorter than for other types of tailgate arrangements and hoisting methods studied.

It was estimated that from 3 to 15 percent of the trucks received at the various grain elevators studied were self-dumping trucks; however, the number of those trucks being used was increasing.

The simple hook hoist for unloading trucks (fig. 3C), while not as fast or economical as the self-dumping truck, has some advantages over the cradle hoist. With the hook hoist it is not necessary to raise the entire front end of the truck (only the truck bed), and the major cause of trucks being hard to start after unloading is eliminated. This type of hoist requires that farmers hinge their truck beds, but this can be done at a nominal cost.

Figure 7 shows an improved type of hook hoist that has only one hook to lift the truck bed. One pitman can set the single hook for lifting, without assistance, while the other pitman operates the hoist.

# IMPROVED METHOD

## *Unloading Self-Dump Trucks*

### Trucks Have Full-Width Tailgate with Lever Latch

### Single-Pit Layout, 1 Man

| | DRIVER | MINUTES | PITMAN | MINUTES |
|---|---|---|---|---|
| 0.10 – 0.20 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | RECEIVES MOISTURE TICKET AND DIRECTS DRIVER | 0.18 |
| 0.30 | WAITS | 0.12 | OPENS TAILGATE | 0.12 |
| 0.40 – 0.70 | RAISES TRUCK BED | 0.39 | WAITS | 0.39 |
| 0.80 – 1.30 | WAITS | 0.63 | CLEANS TRUCK BED | 0.49 |
| | | | CLOSES TAILGATE | 0.14 |
| 1.40 – 1.50 | LOWERS TRUCK BED | 0.17 | CLEANS PIT EDGES | 0.29 |
| 1.60 | DRIVES TRUCK AWAY | 0.12 | | |
| 1.70 | | | | |

PRODUCTIVE LABOR (MAN-MINUTES) 1.22
UNPRODUCTIVE LABOR (MAN-MINUTES) 0.39
TOTAL ELAPSED TIME (MINUTES) 1.61

Figure 6.

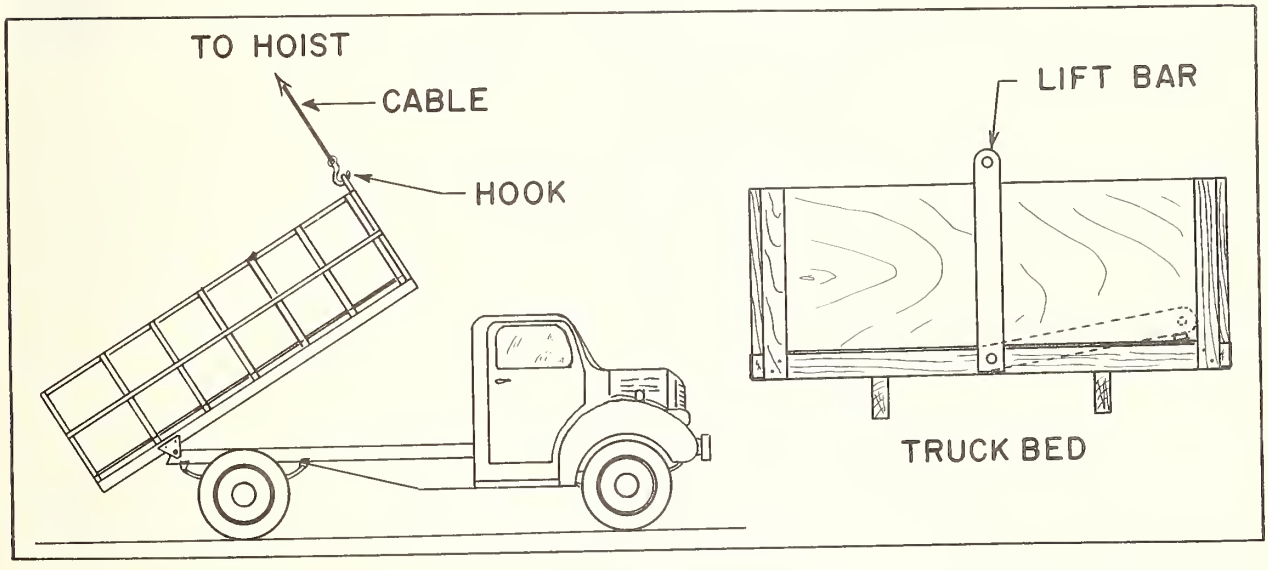


Figure 7.--Improved single-hook hoist requires only one man to set hook for raising grain bed.

Figure 8 shows the work assignments and labor requirements for a 2-man crew using the single-hook hoist to dump a truck at a single-pit layout; each pitman waits about 30 percent of the time (fig. 8, shaded area). Figure 9 shows the requirements for a 3-man crew, using the same equipment, to dump two truckloads at a double-pit layout. The three pitmen are idle a total of 2.5 minutes during this operation (fig. 9, shaded area). An average time of 0.30 minute for opening the tailgate, and the same for closing it, was used in figures 8 and 9.

## IMPROVED METHOD

### *Unloading Trucks Using a Single-Hook Hoist*

### Single-Pit Layout, 2-Man Crew

| | DRIVER | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | RECEIVES MOISTURE TICKET AND DIRECTS POSITIONING | 0.18 | WAITS | 0.18 |
| 0.20 | | | | | | |
| 0.30 | WAITS | 2.66 | OPERATES HOIST TO SET HOOK | 0.19 | SETS HOOK | 0.19 |
| 0.40 | | | | | WALKS TO TAILGATE | 0.05 |
| 0.50 | | | CHOCKS WHEEL | 0.10 | | |
| 0.60 | | | | | OPENS TAILGATE | 0.30 |
| 0.70 | | | WAITS | 0.32 | | |
| 0.80 | | | | | REMOVES FLAP | 0.07 |
| 0.90 | | | RAISES TRUCK BED | 0.24 | | |
| 1.00 | | | | | WAITS | 0.46 |
| 1.10 | | | | | | |
| 1.20 | | | WAITS | 0.28 | | |
| 1.30 | | | | | | |
| 1.40 | | | WALKS TO TRUCK | 0.05 | | |
| 1.50 | | | ASSISTS WITH GRAIN SHOVELING | 0.30 | SHOVELS GRAIN | 0.41 |
| 1.60 | | | | | | |
| 1.70 | | | WALKS TO HOIST CONTROL | 0.05 | | |
| 1.80 | | | RAISES TRUCK BED | 0.21 | WAITS | 0.26 |
| 1.90 | | | | | | |
| 2.00 | | | WAITS | 0.19 | | |
| 2.10 | | | | | | |
| 2.20 | | | WALKS TO TRUCK | 0.05 | CLEANS TRUCK BED | 0.49 |
| 2.30 | | | ASSISTS WITH CLEANING TRUCK BED | 0.20 | | |
| 2.40 | | | WALKS TO HOIST CONTROL | 0.05 | | |
| 2.50 | | | | | REPLACES FLAP | 0.10 |
| 2.60 | | | LOWERS TRUCK BED | 0.43 | CLOSES TAILGATE | 0.30 |
| 2.70 | | | | | | |
| 2.80 | | | | | | |
| 2.90 | | | OPERATES HOIST TO REMOVE HOOK | 0.15 | WALKS TO AND REMOVES HOOK | 0.10 |
| 3.00 | BOARDS TRUCK AND STARTS ENGINE | 0.30 | | | | |
| 3.10 | | | REMOVES WHEEL CHOCK | 0.10 | CLEANS PIT EDGES | 0.29 |
| 3.20 | | | | | | |
| 3.30 | DRIVES AWAY | 0.12 | WAITS | 0.17 | WAITS | 0.06 |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | 2.30 | | 2.30 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | 0.96 | | 0.96 |
| | TOTAL ELAPSED TIME (MINUTES) | | | 3.26 | | |

Figure 8.

# IMPROVED METHOD

## *Unloading Trucks Using Single-Hook Hoists*

### Double-Pit Layout, 3-Man Crew

| | DRIVER A | MINUTES | DRIVER B | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES | PITMAN 3 | MINUTES |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | BOARDS TRUCK AND STARTS ENGINE | 0.09 | RECEIVES MOISTURE TICKET AND DIRECTS DRIVER A | 0.18 | WAITS | 0.18 | WAITS | 0.16 |
| 0.20 | | | DRIVES AWAY | 0.12 | | | | | | |
| 0.30 | | | DRIVES TRUCK OVER PIT | 0.18 | OPERATES HOIST TO SET HOOK ON TRUCK A | 0.19 | SETS HOOK ON TRUCK A | 0.19 | RECEIVES MOISTURE TICKET FROM DRIVER B | 0.18 |
| 0.40 | | | | | | | | | | |
| 0.50 | | | | | OPERATES HOIST TO SET HOOK ON TRUCK B | 0.19 | CHOCKS WHEEL TRUCK A | 0.10 | SETS HOOK ON TRUCK B | 0.19 |
| 0.60 | | | | | | | WALKS TO TAILGATE | 0.05 | | |
| 0.70 | | | | | | | | | CHOCKS WHEEL TRUCK B | 0.10 |
| 0.80 | | | | | WAITS | 0.33 | OPENS TAILGATE TRUCK A | 0.30 | WALKS TO TAILGATE | 0.05 |
| 0.90 | | | | | | | REMOVES FLAP | 0.07 | OPENS TAILGATE TRUCK B | 0.30 |
| 1.00 | | | | | RAISES TRUCK A BED | 0.24 | | | | |
| 1.10 | | | | | | | WAITS | 0.48 | REMOVES FLAP | 0.07 |
| 1.20 | | | | | RAISES TRUCK B BED | 0.24 | | | | |
| 1.30 | | | | | | | | | WAITS | 0.45 |
| 1.40 | | | | | | | | | | |
| 1.50 | WAITS | 2.81 | WAITS | 2.81 | WAITS | 0.49 | SHOVELS GRAIN PIT A | 0.41 | | |
| 1.60 | | | | | | | | | SHOVELS GRAIN PIT B | 0.41 |
| 1.70 | | | | | | | | | | |
| 1.80 | | | | | | | | | | |
| 1.90 | | | | | | | | | | |
| 2.00 | | | | | RAISES TRUCK A BED | 0.21 | CLEANS EDGES PIT A | 0.29 | | |
| 2.10 | | | | | | | | | CLEANS EDGES PIT B | 0.29 |
| 2.20 | | | | | RAISES TRUCK B BED | 0.21 | | | | |
| 2.30 | | | | | | | | | | |
| 2.40 | | | | | WAITS | 0.28 | CLEANS TRUCK A BED | 0.49 | | |
| 2.50 | | | | | | | | | CLEANS TRUCK B BED | 0.49 |
| 2.60 | | | | | | | | | | |
| 2.70 | | | | | | | REPLACES FLAP A | 0.10 | | |
| 2.80 | | | | | LOWERS TRUCK BEDS A AND B | 0.43 | | | REPLACESFLAP B | 0.10 |
| 2.90 | | | | | | | CLOSES TAILGATE TRUCK A | 0.30 | | |
| 3.00 | | | | | | | | | CLOSES TAILGATE TRUCK B | 0.30 |
| 3.10 | BOARDS TRUCK AND STARTS ENGINE | 0.18 | | | OPERATES HOIST TO REMOVE HOOK A | 0.15 | WALKS TO AND REMOVES HOOK A | 0.10 | | |
| 3.20 | | | | | | | UNCHOCKS WHEEL TRUCK A | 0.10 | WALKS TO AND REMOVES HOOK B | 0.10 |
| 3.30 | DRIVES AWAY | 0.12 | BOARDS TRUCK AND STARTS ENGINE | 0.09 | OPERATES HOIST TO REMOVE HOOK B | 0.15 | WAITS | 0.13 | UNCHOCKS WHEEL TRUCK B | 0.10 |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | | | 2.19 | | 2.50 | | 2.68 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | | | 1.10 | | 0.79 | | 0.61 |
| | TOTAL ELAPSED TIME (MINUTES) | | | | | 3.29 | | | | |

Figure 9.

Figure 10 shows the work assignments and labor required for a 2-man crew using the single-hook hoist to dump a truck equipped with full-width tailgate and lever latch at a single-pit layout. No shoveling is required. The possible elapsed time per truck is 2.33 minutes where elevating capacity is sufficient to handle the grain as fast as it can be dumped. One pitman is idle about 40 percent of the time (fig. 10, shaded).

## IMPROVED METHOD

*Unloading Trucks Using Single-Hook Hoist*

**Trucks Have Full-Width Tailgate with Lever Latch**

**Single-Pit Layout, 2-Man Crew**

| | DRIVER | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 – 0.20 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | RECEIVES MOISTURE TICKET AND DIRECTS POSITIONING | 0.18 | WAITS | 0.18 |
| 0.30 – 0.40 | WAITS | 1.73 | OPERATES HOIST TO SET HOOK | 0.19 | SETS HOOK | 0.19 |
| 0.40 – 0.50 | | | CHOCKS WHEEL | 0.10 | WALKS TO TAILGATE | 0.05 |
| 0.50 – 0.60 | | | WAITS | 0.07 | OPENS TAILGATE | 0.12 |
| 0.60 – 1.00 | | | RAISES TRUCK BED | 0.45 | WAITS | 0.45 |
| 1.00 – 1.10 | | | WALKS TO TRUCK | 0.05 | | |
| 1.10 – 1.50 | | | ASSISTS WITH CLEANING TRUCK BED | 0.39 | CLEANS TRUCK BED | 0.49 |
| 1.50 – 1.60 | | | WALKS TO HOIST CONTROL | 0.05 | | |
| 1.60 – 1.90 | | | LOWERS TRUCK BED | 0.43 | CLOSES TAILGATE | 0.14 |
| | | | | | WAITS | 0.29 |
| 2.00 – 2.20 | BOARDS TRUCK AND STARTS ENGINE | 0.30 | OPERATES HOIST TO REMOVE HOOK | 0.15 | REMOVES HOOK | 0.10 |
| | | | REMOVES WHEEL CHOCK | 0.10 | CLEANS PIT EDGES | 0.29 |
| 2.30 – 2.40 | DRIVES AWAY | 0.12 | WAITS | 0.17 | WAITS | 0.03 |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | 2.09 | | 1.38 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | 0.24 | | 0.95 |
| | TOTAL ELAPSED TIME (MINUTES) | | 2.33 | | | |

Figure 10.

## The Receiving Cycle

Estimated time and labor requirements and labor and equipment costs for the improved methods of weighing and testing (for moisture content only) and unloading and elevating are shown in table 5. The elapsed time and labor requirements for unloading and elevating are based on the assumption that elevating capacity is sufficient to move the grain as fast as it can be unloaded. Computations are given for using the single-hook hoist at single and double pits for trucks with various combinations of tailgate and latch, and for unloading a self-dump truck. The complete receiving cycles were not studied, but each of the operations in the cycle was studied.

Table 5 indicates that the receiving rate is generally not speeded up or receiving costs reduced by providing a double pit, or two single pits, unless additional weighing and testing facilities are provided. Costs included for elevating equipment are the same for each case shown. The differences in equipment costs are due to the use of one or two pits and one or two truck hoists. The self-dump truck requires no truck hoist.

Table 5.--Improved methods: Labor and equipment costs for receiving one truckload of grain sorghum

[When the grain is tested only for moisture content]

| Hoisting method, types of pit layout and truck tailgate and latch | Crew size[1] | Elapsed time for[2]- | | Wait time between operations | Total | | Costs | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Weighing and testing | Unloading and elevating[3] | | Elapsed time | Labor required | Labor[4] | Equipment | Total |
| Single-hook hoist: | | | | | | | | | |
| One single pit, truck with full-width tailgate and lever latch | No. 4 | Minutes 2.14 | Minutes 2.33 | Minutes 0.19 | Minutes 2.33 | Man-minutes 9.32 | Dollars 0.19 | Dollars 1.39 | Dollars 1.58 |
| One single pit, trucks with various combinations of tailgate and latch, average | 4 | 2.14 | 3.26 | 1.12 | 3.26 | 13.04 | .27 | 1.39 | 1.66 |
| One double pit, trucks with various combinations of tailgate and latch, average[5] | 5 | [5] 4.28 | [5] 3.29 | [5] .99 | [5] 4.28 | [5] 21.40 | .23 | 1.70 | 1.93 |
| Self-dump truck: | | | | | | | | | |
| One single pit, truck with full-width tailgate and lever latch | 3 | 2.14 | 1.61 | .53 | 2.14 | 6.42 | .13 | 1.31 | 1.44 |

[1] In each case, the weighing and testing crew is two men at one platform scale.

[2] The sequence of work for the weighing and testing operation is shown in figure 4 and for the unloading and elevating operations in figures 6, 8, 9, and 10.

[3] Sufficient elevating capacity must be available if these unloading rates are to be maintained.

[4] An average rate of $1.25 per hour is used.

[5] For the double pit the time and labor requirements shown are for two trucks, but costs are the average for one truck.

Costs for receiving trucks with various combinations of tailgate and latch at both the single and double pit are lower with the improved methods than with the observed methods. The cost per truckload at a single pit and using a single-hook hoist is $1.66 with the improved methods. When a cradle hoist is used with the observed methods, the cost per truckload is $2.13, and when a platform hoist is used, the cost is $3.17 (table 3).

## Layout of Receiving Facility

The layout of the receiving facilities is important to assure a smooth, uninterrupted flow of trucks. The traffic flow for both loaded and empty trucks should be kept in one direction across the scale to eliminate lost time. If the flow is not in one direction, trucks must pass a point 50 or 60 feet beyond the scale before trucks approaching the scale from the opposite direction can drive onto the scale. The scale house and scale should be so arranged that truckdrivers are always on the scale-house side of the truck when they drive onto the scale. Then, if the driver dismounts from the truck and walks to the scale-house window, he clears the scale very quickly, and boarding the truck is also less time-consuming. If he stays aboard the truck, he is easily reached by the person who transfers the tickets to him. This arrangement makes it possible for the driver to keep the engine running and be ready to drive the truck off the scale as quickly as he receives the ticket.

The layout of the driveway to the dump pit is determined by the number of pits at the elevator. The driveway should provide easy access to each pit, and easy re-entrance to the scale for empty trucks. Figure 11 shows an arrangement of driveways, pits, scale, and storage bins for a multiple-pit layout. Empty trucks should have the right-of-way on returning to the scale.

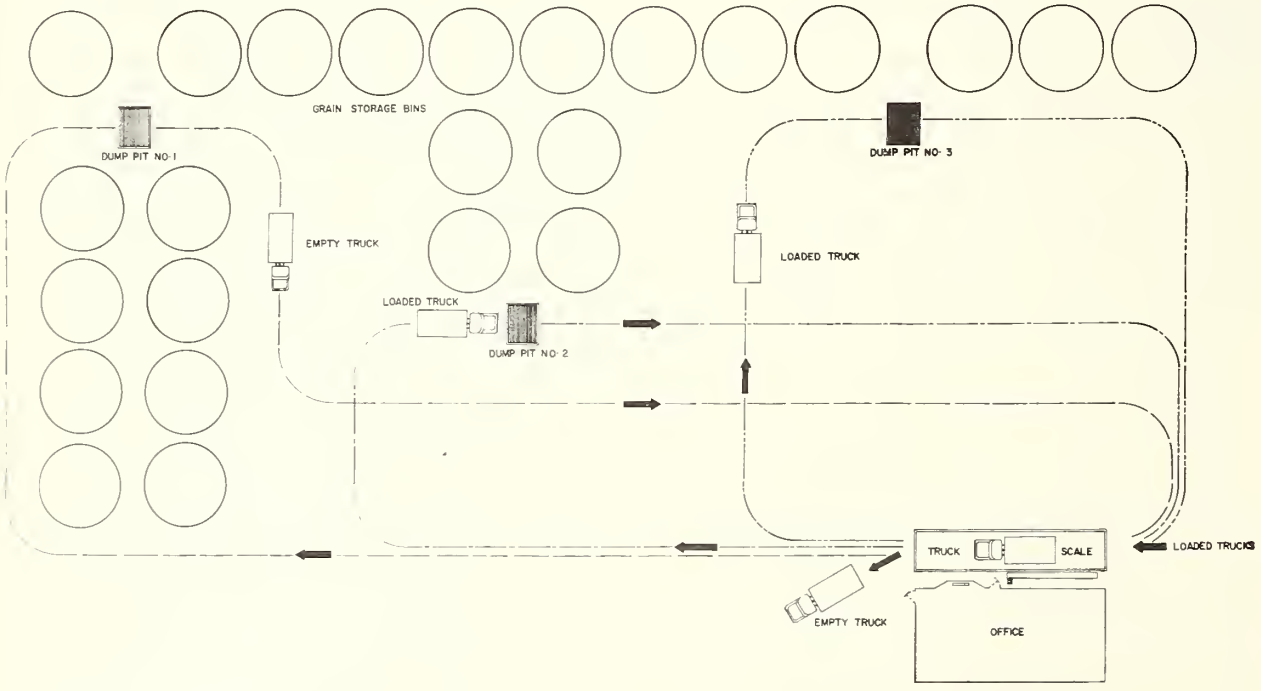


Figure 11.--Three-pit layout showing movement of trucks in one direction across the scale with a minimum number of truck paths to and from dump pits.

## The Scale House

Adequate window area properly arranged helps the scale operator to control the weighing operation and to function efficiently. If the area of vision is sufficient for him to identify trucks and drivers approaching the scale, he can weigh the trucks without hesitation. An opening should be provided in the window through which scale tickets can be passed easily. The position of the window in the scale house should permit drivers aboard the trucks to obtain an easy view of the scale dial during weighing (fig. 12).

The location of equipment used by the scale operator should allow him to function freely with a minimum of effort. Since the controls on the scale are on the right-hand side, the scale desk should be to the right of the scale dial. The window opening should be within easy reach from the desk. Scale tickets should be placed as near as possible to the place where they are first used.

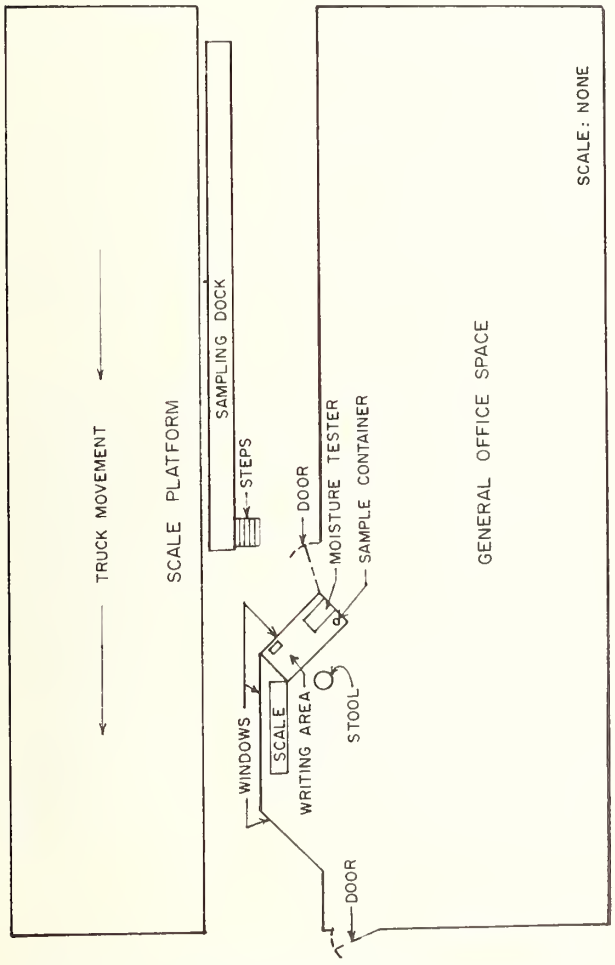


Figure 12.--Improved scale house arrangement.

Scale operations.--Periodic reviews of the information required on scale tickets will help to minimize the amount of writing required of the scaleman. To speed up the weighing operation, as much information as possible should be filled in before trucks reach the scale.

Sampling and testing.--A sampling dock should be built near the scale on the side near the scale house. The dock should be alongside the truck bed when the truck is stopped in position for the truckdriver to see the dial of the scale. The sampling dock must be long enough to accommodate all trucks that deliver grain to the elevator. Placing the dock next to the scale shortens the distance the sampler must walk to do the sampling.

Triers (probes), sample containers, and ladders should be located along the line the sampler travels to obtain the sample. A convenient location is required for the beam and cup if a test weight is to be made at the truck.

If a scale is needed for weighing samples, it should be located beside the moisture tester. An oil balance gram scale will save approximately one-fifth of a minute per sample over other common types. The moisture conversion chart should be placed on a board slanted about 60 degrees from horizontal, directly behind the dial of the tester. If located on the wall behind the test bench, it should be at eye level. If the moisture tester has a cup that must be emptied after each test, a container should be placed below the tester so that the operator can empty the cup quickly.

## The Dump Pit

Dump pits for the Southwest should hold from 30,000 to 40,000 pounds. This size will hold from 2 to 3 loads from bobtail trucks or one load from a tractor-trailer. It also will provide the grain needed to keep the handling equipment running while trucks are entering

and leaving the pit area during the normal receiving operation.

The way grain is removed from the pit--by gravity or by conveyor--usually depends on the arrangement of bins and the pits. Whatever the method, all of the pit walls should be sloped no less than 45 degrees to allow the grain to flow freely.

The pit grate must be large enough to prevent excessive moving backward and forward of trucks in positioning for unloading. An opening at least 10 feet wide by 10 feet long is normally sufficient. A pit that extends from wall to wall (fig. 13A) prevents spillover of grain. If smaller pits are used, sideboards on the pits (fig. 13B) will prevent excessive spillover, but their use necessitates greater care in positioning trucks.

Hoist controls should be located at the rear of the pit on the driver's side of the truck. Button-type controls work only while the button is depressed and require the full time of the operator to raise and lower the trucks. Button-type controls were in common use during the studies, probably because of the safety factor. The lever type of hoist control does not require the operator to hold it in position and reduces the labor input. There was ample time for the hoist control operator to chock and unchock the rear wheel nearest him during the raising and lowering of the truck. Shovels, crowbars, brooms, rakes, and other equipment used in unloading trucks should be hung on the wall on each side of the pit.

Rails upon which the truck hoist is mounted should be at least 16 feet high to allow a farm truck to be raised at least 35 degrees. Special care should be exercised that cross members do not restrict height of the lift.

Doors to pit enclosures varied considerably in size. Narrow entrance and exit doors for trucks at dump pits caused considerable delay. Truckdrivers normally slowed down on approaching narrow doors, and if there was an inclined driveway, the trucks sometimes stalled. A clearance of 3 feet on each side of the truck (door about 14 feet wide) allowed the driver to enter the door or driveway at a steady pace. Door heights studied--10 to 12 feet--were sufficient for farm trucks. Since however, self-dumping trucks occasionally started to leave before the bed was lowered, an exit door 16 feet high is desirable, especially if the rear wheels of the truck have to cross over the cradle just before reaching the exit door.

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Figure 13.--(A) Dump pit with grate opening extending from wall to wall. (B) Dump pit with sideboards to prevent spillover of grain.

## LABOR REQUIREMENTS FOR SOME OF THE OBSERVED METHODS

The activity charts in figures 14 through 26 show the labor requirements (productive and unproductive) and the elements of work involved in some of the receiving operations observed during the studies.

### Weighing and Testing

#### Combined Weighing and Testing

Figure 14 shows the labor requirements, elements of work, and the unproductive (idle) time involved in a 2-man crew weighing one truck (loaded and empty) and making a moisture test. The total elapsed time was 3.2 minutes and the labor requirements were 6.4 man-minutes for the 2-man crew. The moisture-test operator waited over 50 percent of the time, mainly while the empty truck was being weighed. The scale operator waited 35 percent of the time.

Generally, a third worker (test-weight operator) was used when a test-weight determination was required. The moisture-test operator collects the grain sample and gives a portion to the third worker. When these workers complete the grain tests, the scale operator records the moisture content and test weight on the scale ticket. The test-weight operator hands a report of the moisture and test weight to the driver to take to the pit crew.

The total elapsed time for the operation was 2.85 minutes, and the total labor requirements were 8.55 man-minutes. The test-weight operator was idle (waited) some 65 percent of the time and the moisture-test operator about 40 percent of the time, as shown in tabulation.

| | Productive labor | Unproductive labor |
|---|---|---|
| Scale operator | 2.21 | 0.64 |
| Moisture-test operator | 1.70 | 1.15 |
| Test-weight operator | .98 | 1.87 |
| Total man-minutes | 4.89 | 3.66 |

#### Independent Weighing and Testing

When the testing is done at a station separate from the scale house, one man can collect the grain samples and make the moisture test in 1.97 minutes. Two men can make the moisture and test-weight determinations in 1.83 minutes (fig. 15), but the two are idle for 1.38 man-minutes.

When testing was done in the scale house, but independently of weighing, the total elapsed time for one worker to walk to the trucks, collect samples from two trucks, return to the scale house, and make the moisture tests was 5.12 minutes, an average of 2.6 minutes per truck (fig. 16).

Figure 17 shows the labor required for two men to make the moisture and test-weight determinations.

One man (the sampler) obtains grain samples from the trucks, and the other makes moisture and test-weight determinations. The labor requirements were 6.08 man-minutes, an average of 3.04 man-minutes per truck.

With the independent method of weighing and testing at separate stations, the scale operator can weigh a loaded and an empty truck, and record the moisture on the scale ticket in 2.39 minutes (fig. 18).

# OBSERVED METHOD

## *Combined Weighing and Testing, 2-Man Crew*

## Moisture Test Only

| | TRUCK DRIVER | MINUTES | SCALE OPERATOR | MINUTES | TEST OPERATOR | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 | DRIVES LOADED TRUCK ONTO SCALE | 0.12 | WAITS | 0.18 | WAITS | 0.12 |
| 0.20 | DISMOUNTS, WALKS TO WINDOW AND GIVES INFORMATION | 0.23 | STARTS TICKET FOR LOADED TRUCK | 0.17 | COLLECTS SAMPLE (THREE PROBES) | 0.40 |
| 0.30 | | | | | | |
| 0.40 | WAITS AT WINDOW | 1.07 | WEIGHS LOADED TRUCK | 0.20 | | |
| 0.50 | | | | | | |
| 0.60 | | | PRINTS TICKET | 0.04 | TRANSPORTS SAMPLE (18') | 0.13 |
| 0.70 | | | CONTINUES TICKET FOR LOADED TRUCK | 0.36 | WEIGHS SAMPLE | 0.39 |
| 0.80 | | | | | | |
| 0.90 | | | | | | |
| 1.00 | | | | | | |
| 1.10 | | | WAITS | 0.42 | POURS SAMPLE INTO MOISTURE TESTER | 0.12 |
| 1.20 | | | | | TESTS SAMPLE | 0.12 |
| 1.30 | | | | | | |
| 1.40 | | | | | READS MOISTURE, REPORTS TO SCALE OPERATOR | 0.09 |
| 1.50 | RECEIVES REPORT | 0.07 | RECORDS AND HANDS MOISTURE REPORT TO DR'VR. | 0.12 | CLEANS TESTER | 0.19 |
| 1.60 | BOARDS TRUCK AND STARTS ENGINE | 0.31 | FINISHES TICKET FOR LOADED TRUCK | 0.18 | WALKS TO DOCK | 0.13 |
| 1.70 | | | | | | |
| 1.80 | | | LAYS TICKET ASIDE | 0.08 | | |
| 1.90 | DRIVES AWAY | 0.10 | WAITS | 0.15 | | |
| 2.00 | DRIVES EMPTY TRUCK ONTO SCALE | 0.11 | INSERTS TICKET FOR EMPTY TRUCK IN SCALE | 0.11 | | |
| 2.10 | DISMOUNTS FROM TRUCK AND WALKS TO WINDOW | 0.14 | WEIGHS EMPTY TRUCK | 0.20 | | |
| 2.20 | | | | | | |
| 2.30 | WAITS AT WINDOW | 0.57 | PRINTS TICKET | 0.04 | WAITS | 1.51 |
| 2.40 | | | | | | |
| 2.50 | | | WRITES TICKET FOR EMPTY TRUCK | 0.47 | | |
| 2.60 | | | | | | |
| 2.70 | | | | | | |
| 2.80 | RECEIVES TICKET | 0.07 | HANDS TICKET TO DRIVER | 0.07 | | |
| 2.90 | BOARDS TRUCK AND STARTS ENGINE | 0.31 | LAYS COPY ASIDE | 0.08 | | |
| 3.00 | | | | | | |
| 3.10 | | | WAITS | 0.33 | | |
| 3.20 | DRIVES AWAY | 0.10 | | | | |

| | | | |
|---|---|---|---|
| PRODUCTIVE LABOR (MAN-MINUTES) | | 2.12 | 1.57 |
| UNPRODUCTIVE LABOR (MAN-MINUTES) | | 1.08 | 1.63 |
| ELAPSED TIME (MINUTES) | 3.20 | | |

Figure 14

## OBSERVED METHOD

*Independent Testing at Facilities Separate from Scale House, 2-Man Crew*

**Moisture and Test-Weight Determinations**

| | TRUCKDRIVER | MINUTES | TEST OPERATOR | MINUTES | TEST-WEIGHT OPERATOR | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 | POSITIONS TRUCK | 0.12 | | | WAITS | 0.12 |
| 0.20 | | | | | | |
| 0.30 | | | | | COLLECTS SAMPLE (THREE PROBES) | 0.40 |
| 0.40 | | | WAITS | 0.73 | | |
| 0.50 | | | | | | |
| 0.60 | | | | | TRANSPORTS SAMPLE (18 FT.) | 0.13 |
| 0.70 | | | | | FILLS CUP | 0.04 |
| 0.80 | | | | | PLACES CUP BY SCALE | 0.04 |
| 0.90 | | | WEIGHS SAMPLE (150 GRAMS) | 0.39 | LEVELS GRAIN IN CUP | 0.08 |
| 1.00 | WAITS | 1.54 | | | DETERMINES TEST WEIGHT | 0.14 |
| 1.10 | | | | | RECORDS TEST-WT. | 0.06 |
| 1.20 | | | | | EMPTIES CUP | 0.04 |
| 1.30 | | | | | LAYS REPORT ASIDE | 0.04 |
| 1.40 | | | POURS SAMPLE IN TESTER | 0.12 | | |
| 1.50 | | | TESTS SAMPLE | 0.12 | | |
| 1.60 | | | READS CHART | 0.09 | WAITS | 0.51 |
| 1.70 | | | RECORDS MOISTURE | 0.05 | | |
| 1.80 | | | WRITES LOG ENTRY | 0.10 | | |
| | | | HANDS REPORT TO TEST-WEIGHT OPR. | 0.04 | RECEIVES REPORT | 0.04 |
| | RECEIVES TICKET | 0.07 | CLEANS TESTER | 0.19 | HANDS REPORT TO DRIVER | 0.07 |
| | DRIVES AWAY | 0.10 | | | PREPARES NEXT REPORT | 0.10 |
| | | | | | WAITS | 0.02 |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | 1.10 | | 1.18 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | .73 | | .65 |
| | ELAPSED TIME (MINUTES) | | | 1.83 | | |

Figure 15

## OBSERVED METHOD

*Independent Testing at Scale House, 1 Man*

**Moisture Test Only**

| SCALE MINUTES | MOISTURE TEST OPERATOR | MINUTES |
|---|---|---|
| 0.10 | | |
| 0.20 | | |
| 0.30 | WALKS 125 FEET FOR SAMPLE, PICKS UP PROBE AND LADDER ALONG THE WAY. PLACES LADDER AGAINST SIDE OF TRUCK. | 0.59 |
| 0.40 | | |
| 0.50 | | |
| 0.60 | | |
| 0.70 | BOARDS TRUCK | 0.11 |
| 0.80 | | |
| 0.90 | COLLECTS SAMPLE | 0.40 |
| 1.00 | | |
| 1.10 | | |
| 1.20 | DISMOUNTS FROM TRUCK | 0.19 |
| 1.30 | | |
| 1.40 | NUMBERS TRUCK AND TICKET AND PLACES TICKET IN SAMPLE CAN | 0.12 |
| 1.50 | WALKS TO NEXT TRUCK (25 FEET). PLACES LADDER AGAINST BED. | 0.11 |
| 1.60 | BOARDS TRUCK | 0.11 |
| 1.70 | | |
| 1.80 | COLLECTS SAMPLE | 0.40 |
| 1.90 | | |
| 2.00 | | |
| 2.10 | | |
| 2.20 | DISMOUNTS FROM TRUCK | 0.19 |
| 2.30 | NUMBERS TRUCK AND TICKET | 0.12 |
| 2.40 | | |
| 2.50 | | |
| 2.60 | TRANSPORTS SAMPLES TO SCALE HOUSE (150') | 0.70 |
| 2.70 | | |
| 2.80 | | |
| 2.90 | | |
| 3.00 | | |
| 3.10 | | |
| 3.20 | WEIGHS 150 GRAMS OF FIRST SAMPLE | 0.39 |
| 3.30 | | |
| 3.40 | POURS SAMPLE IN TESTER | 0.12 |
| 3.50 | TESTS SAMPLE | 0.12 |
| 3.60 | READS CHART | 0.09 |
| 3.70 | WRITES MOISTURE CONTENT ON DRIVER'S TICKET | 0.05 |
| 3.80 | LAYS TICKET ON SCALE DESK (4 FEET) | 0.08 |
| 3.90 | CLEANS TESTER | 0.19 |
| 4.00 | | |
| 4.10 | | |
| 4.20 | WEIGHS 150 GRAMS OF SECOND SAMPLE | 0.39 |
| 4.30 | | |
| 4.40 | | |
| 4.50 | POURS SAMPLE IN TESTER | 0.12 |
| 4.60 | TESTS SAMPLE | 0.12 |
| 4.70 | READS CHART | 0.09 |
| 4.80 | WRITES MOISTURE CONTENT ON DRIVER'S TICKET | 0.05 |
| 4.90 | LAYS TICKET ON SCALE DESK (4 FEET) | 0.08 |
| 5.00 | CLEANS TESTER | 0.19 |
| 5.10 | | |
| | PRODUCTIVE LABOR (MAN-MINUTES) | 5.12 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | 0.00 |
| | TOTAL ELAPSED TIME (MINUTES) 5.12 | |

Figure 16

# OBSERVED METHOD

## *Independent Testing at Scale House, 2-Man Crew*

## Moisture and Test-Weight Determinations

| | TEST OPERATOR | MINUTES | SAMPLER | MINUTES |
|---|---|---|---|---|
| 0.10 | FILLS TEST-WEIGHT CUP | 0.04 | WALKS FOR SAMPLE (125') | 0.59 |
| 0.20 | WEIGHS 150-GRAM SAMPLE | 0.39 | | |
| 0.30 | | | | |
| 0.40 | | | | |
| 0.50 | POURS SAMPLE IN TESTER | 0.12 | | |
| 0.60 | TESTS SAMPLE | 0.12 | | |
| 0.70 | | | BOARDS TRUCK | 0.11 |
| 0.80 | READS CHART | 0.09 | COLLECTS SAMPLE | 0.40 |
| | WRITES REPORT FOR DRIVER | 0.05 | | |
| 0.90 | LEVELS TEST-WEIGHT CUP | 0.08 | | |
| 1.00 | BALANCES SCALE | 0.14 | | |
| 1.10 | RECORDS TEST-WEIGHT | 0.05 | | |
| 1.20 | PLACES REPORT ON SCALEMAN'S DESK | 0.08 | DISMOUNTS FROM TRUCK | 0.19 |
| | EMPTIES TEST-WEIGHT CUP | 0.04 | | |
| 1.30 | CLEANS MOISTURE TESTER | 0.19 | NUMBERS TRUCK AND SLIP. PLACES NUMBER IN SAMPLE CONTAINER | 0.12 |
| 1.40 | | | | |
| | FILLS TEST-WEIGHT CUP | 0.04 | | |
| 1.50 | WEIGHS 150 GRAM SAMPLE | 0.39 | WALKS TO NEXT TRUCK (25') | 0.11 |
| 1.60 | | | BOARDS TRUCK | 0.11 |
| 1.70 | | | COLLECTS SAMPLE | 0.40 |
| 1.80 | | | | |
| 1.90 | POURS SAMPLE IN TESTER | 0.12 | | |
| 2.00 | TESTS SAMPLE | 0.12 | | |
| 2.10 | | | | |
| 2.20 | READS CHART | 0.09 | DISMOUNTS FROM TRUCK | 0.19 |
| | WRITES REPORT FOR DRIVER | 0.05 | | |
| 2.30 | LEVELS TEST-WEIGHT CUP | 0.08 | NUMBERS TRUCK AND SLIP. PLACES NUMBER IN SAMPLE CONTAINER | 0.12 |
| 2.40 | BALANCES SCALE | 0.14 | | |
| 2.50 | RECORDS TEST-WEIGHT | 0.05 | | |
| 2.60 | PLACES REPORT ON SCALEMAN'S DESK | 0.08 | | |
| | EMPTIES TEST-WEIGHT CUP | 0.04 | TRANSPORTS SAMPLES (150') | 0.70 |
| 2.70 | CLEANS MOISTURE TESTER | 0.19 | | |
| 2.80 | | | | |
| 2.90 | WAITS | 0.26 | | |
| 3.00 | | | | |
| | PRODUCTIVE LABOR (MAN-MINUTES) | 2.78 | | 3.04 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | 0.26 | | |
| | ELAPSED TIME (MINUTES) | 3.04 | | |

Figure 17

# OBSERVED METHOD

## *Independent Weighing, 1 Man*

| | TRUCKDRIVER | | SCALE OPERATOR | |
|---|---|---|---|---|
| | | MINUTES | | MINUTES |
| 0.10 | DRIVES TRUCK ONTO SCALE | 0.12 | WRITES TICKET FOR LOADED TRUCK | 0.18 |
| 0.20 | DISMOUNTS FROM TRUCK AND WALKS TO WINDOW | 0.14 | | |
| 0.30 | | | WEIGHS LOADED TRUCK | 0.20 |
| 0.40 | WAITS | 0.16 | | |
| 0.50 | | | PRINTS TICKET | 0.04 |
| 0.60 | SHOWS MOISTURE TICKET AND GIVES INFORMATION | 0.09 | RECORDS MOISTURE CONTENT | 0.05 |
| 0.70 | WAITS | 0.17 | | |
| 0.80 | | | COMPLETES TICKET FOR LOADED TRUCK | 0.54 |
| 0.90 | BOARDS TRUCK AND STARTS ENGINE | 0.31 | | |
| 1.00 | | | | |
| 1.10 | DRIVES AWAY | 0.10 | LAYS TICKET ASIDE | 0.08 |
| 1.20 | DRIVES EMPTY TRUCK ONTO SCALE | 0.11 | FINDS TICKET FOR EMPTY TRUCK | 0.06 |
| | | | INSERTS TICKET IN SCALE | 0.05 |
| 1.30 | DISMOUNTS FROM TRUCK AND WALKS TO WINDOW | 0.14 | WEIGHS EMPTY TRUCK | 0.20 |
| 1.40 | | | | |
| 1.50 | | | PRINTS TICKET | 0.04 |
| 1.60 | WAITS | 0.57 | | |
| 1.70 | | | WRITES TICKET FOR EMPTY TRUCK | 0.47 |
| 1.80 | | | | |
| 1.90 | | | | |
| 2.00 | RECEIVES TICKET | 0.07 | HANDS TICKET TO DRIVER | 0.07 |
| 2.10 | | | LAYS COPY ASIDE | 0.08 |
| 2.20 | BOARDS TRUCK AND STARTS ENGINE | 0.31 | | |
| 2.30 | | | WAITS | 0.33 |
| 2.40 | DRIVES AWAY | 0.10 | | |

PRODUCTIVE LABOR (MAN-MINUTES) 2.06
UNPRODUCTIVE LABOR (MAN-MINUTES) 0.33
TOTAL ELAPSED TIME (MINUTES) 2.39

Figure 18

## Unloading and Elevating

The work assignments and labor requirements for a 2-man crew using a cradle hoist to dump trucks into a single pit are shown in figure 19 and for a 3-man crew in figure 20. Similar information for other combinations of equipment and methods are given in the appendix (figs. 21 through 26). An average time of 0.30 minute was used for opening or closing the tailgate. It was assumed that no matter which type of tailgate was used some shoveling was required to complete the unloading.

The shaded areas in these activity charts on unloading illustrate the excessive amount of idle or wait time, ranging from 50 percent up to 96 percent for certain pitmen, caused by the slow elevating rates in use.

# OBSERVED METHOD

## *Unloading Trucks Using Cradle Hoist*

### Single-Pit Layout, 2-Man Crew

| | DRIVER | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.17 | RECEIVES MOISTURE TICKET FROM DRIVER | 0.17 | WAITS | 0.37 |
| 0.20 | | | | | | |
| 0.30 | POSITIONS TRUCK | 0.20 | OPERATES HOIST AND DIRECTS DRIVER | 0.20 | | |
| 0.40 | | | | | | |
| 0.50 | | | CHOCKS WHEELS | 0.10 | | |
| 0.60 | | | | | OPENS TAILGATE | 0.30 |
| 0.70 | | | WAITS | 0.27 | | |
| 0.80 | | | | | REMOVES FLAP | 0.07 |
| 0.90 | | | | | | |
| 1.00 | | | RAISES CRADLE | 0.48 | WAITS | 0.67 |
| 1.10 | | | | | | |
| 1.20 | | | | | | |
| 1.30 | | | WAITS | 0.20 | | |
| 1.40 | | | | | | |
| 1.50 | | | WALKS TO TRUCK | 0.05 | | |
| 1.60 | | | | | | |
| 1.70 | | | ASSISTS WITH GRAIN SHOVELING | 0.30 | SHOVELS GRAIN | 0.41 |
| 1.80 | | | | | | |
| 1.90 | | | WALKS TO HOIST CONTROL | 0.05 | | |
| 2.00 | WAITS | 3.45 | RAISES CRADLE | 0.30 | | |
| 2.10 | | | | | | |
| 2.20 | | | | | WAITS | 0.71 |
| 2.30 | | | | | | |
| 2.40 | | | | | | |
| 2.50 | | | | | | |
| 2.60 | | | WAITS | 0.65 | | |
| 2.70 | | | | | | |
| 2.80 | | | | | | |
| 2.90 | | | WALKS TO TRUCK | 0.05 | CLEANS TRUCK BED | 0.49 |
| 3.00 | | | ASSISTS WITH CLEANING TRUCK BED | 0.20 | | |
| 3.10 | | | WALKS TO HOIST CONTROL | 0.05 | | |
| 3.20 | | | | | CLEANS PIT EDGES | 0.29 |
| 3.30 | | | | | | |
| 3.40 | | | | | REPLACES FLAP | 0.10 |
| 3.50 | | | LOWERS CRADLE | 0.75 | | |
| 3.60 | | | | | CLOSES TAILGATE | 0.30 |
| 3.70 | | | | | | |
| 3.80 | | | | | | |
| 3.90 | | | REMOVES CHOCKS FROM WHEELS | 0.10 | | |
| 4.00 | BOARDS TRUCK AND STARTS ENGINE | 0.30 | | | WAITS | 0.53 |
| 4.10 | | | WAITS | 0.32 | | |
| 4.20 | DRIVES AWAY | 0.12 | | | | |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | 2.80 | | 1.96 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | 1.44 | | 2.28 |
| | TOTAL ELAPSED TIME (MINUTES) | | 4.24 | | | |

Figure 19

# OBSERVED METHOD

## *Unloading Trucks Using Cradle Hoist*

## Single-Pit Layout, 3-Man Crew

| SCALE MINUTES | TRUCKDRIVER | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES | PITMAN 3 | MINUTES |
|---|---|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS ON CRADLE | 0.17 | RECEIVES MOISTURE TICKET FROM DRIVER | 0.17 | WAITS | 0.37 | WAITS | 1.41 |
| 0.20 | | | | | | | | |
| 0.30 | POSITIONS TRUCK | 0.20 | OPERATES HOIST AND DIRECTS POSITIONING | 0.20 | | | | |
| 0.40 | | | | | | | | |
| 0.50 | WAITS | 3.45 | CHOCKS WHEELS | 0.10 | OPENS TAILGATE | 0.30 | | |
| 0.60 | | | | | | | | |
| 0.70 | | | WAITS | 0.27 | | | | |
| 0.80 | | | | | REMOVES FLAP | 0.07 | | |
| 0.90 | | | RAISES CRADLE | 0.48 | WAITS | 0.78 | | |
| 1.00 | | | | | | | | |
| 1.10 | | | | | | | | |
| 1.20 | | | | | | | | |
| 1.30 | | | WAITS | 0.60 | ASSISTS WITH SHOVELING GRAIN | 0.30 | SHOVELS GRAIN | 0.41 |
| 1.40 | | | | | | | | |
| 1.50 | | | | | | | | |
| 1.60 | | | | | | | | |
| 1.70 | | | | | | | | |
| 1.80 | | | | | | | | |
| 1.90 | | | RAISES CRADLE | 0.30 | WAITS | 1.05 | WAITS | 0.76 |
| 2.00 | | | | | | | | |
| 2.10 | | | | | | | | |
| 2.20 | | | | | | | | |
| 2.30 | | | | | | | | |
| 2.40 | | | WAITS | 0.95 | | | | |
| 2.50 | | | | | | | | |
| 2.60 | | | | | | | | |
| 2.70 | | | | | | | | |
| 2.80 | | | | | | | CLEANS TRUCK BED | 0.49 |
| 2.90 | | | | | | | | |
| 3.00 | | | | | ASSISTS WITH CLEANING TRUCK BED | 0.20 | | |
| 3.10 | | | | | | | | |
| 3.20 | | | LOWERS CRADLE | 0.75 | REPLACES FLAP | 0.10 | CLEANS PIT EDGES | 0.29 |
| 3.30 | | | | | CLOSES TAILGATE | 0.30 | | |
| 3.40 | | | | | | | | |
| 3.50 | | | | | WAITS | 0.77 | WAITS | 0.88 |
| 3.60 | | | | | | | | |
| 3.70 | | | | | | | | |
| 3.80 | | | | | | | | |
| 3.90 | | | UNCHOCKS WHEEL | 0.10 | | | | |
| 4.00 | BOARDS TRUCK AND STARTS ENGINE | 0.30 | | | | | | |
| 4.10 | | | WAITS | 0.32 | | | | |
| 4.20 | DRIVES AWAY | 0.12 | | | | | | |

| | | | |
|---|---|---|---|
| PRODUCTIVE LABOR (MAN-MINUTES) | | 2.10 | 1.27 | 1.19 |
| UNPRODUCTIVE LABOR (MAN-MINUTES) | | 2.14 | 2.97 | 3.05 |
| TOTAL ELAPSED TIME (MINUTES) | 4.24 | | | |

Figure 20

# APPENDIX

## Equipment Costs

Most storages for grain sorghum have a capacity of 400 to 500 cars of grain and receive about 300 cars (100,000 pounds per car) of new grain each year. Cost computations used in this report are based on annual receipts of 30 million pounds (300 carloads or 2,300 truckloads) of grain delivered by farm trucks.

Table 6 lists the estimated equipment ownership and operating costs for receiving 2,300 truckloads of grain sorghum per year using specified equipment.

The dump pit is an integral part of the receiving equipment. Costs obtained from elevator operators and construction companies ranged from $2,000 to $10,000 per pit, depending on the capacity. An average cost of $6,000 per pit is used in this report.

Because screw conveyors are commonly used for horizontal conveying, they are included in table 6. The initial cost of screw conveyors is based on the cost of two sections with a motor and drive on each section. Long conveyors were usually divided so that one-half the length of the conveyor served half of the storage sections. Only 40 percent of the use of screw conveyors was charged to receiving.

Most of the elevators studied used one or more legs specifically for receiving, and for this report the entire cost of the leg is charged to receiving. Some operators use receiving legs for shipping and other purposes as well as receiving. If grain is loaded into railroad cars directly from the receiving pit, the receiving leg is used only half as much as when grain is conveyed to storage before shipping.

## Definition of Terms

Productive time or productive labor.--The amount of actual work time necessary to perform an operation or group of operations. Productive time is based on the data shown in table 7.

Unproductive time.--Time spent in waiting; during this time no activity is applied to the job being performed.

Fatigue allowance.--An allowance to compensate for physical and mental stresses that reduce or impair the normal will and capability to work (table 7).

Personal allowance.--An allowance to compensate for the time required for personal needs of the employee (table 7).

Base time.--The time recorded during a time study adjusted to the normal pace of an average experienced worker.

Bucket elevator.--A conveyor consisting of an endless belt, chain or chains, or other linkage to which buckets are attached for carrying materials; it operates in a vertical or inclined path. It is also called a "leg"; this term may be combined with another to designate a specific use, such as "receiving leg".

Screw conveyor.--Also called an auger. It is used to carry bulk material along a trough or other defined path.

Scale operator.--The person who weighs the grain and assigns storage space for it as it is received.

Pitman.--The person assigned to jobs performed in and around the pit where grain is dumped.

Sampler.--A person that collects grain samples from loaded trucks but does not do the testing.

Table 6.--Equipment ownership and operating costs for receiving 2,300 truckloads of grain sorghum per year at an elevator with one truck scale and one double pit or two single pits

| Equipment[1] | Number of items | Initial cost[2] | Expected life | Ownership cost[3] | | | | Operating cost[4] | | | Total cost | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Depreciation | Interest | Insurance and taxes | Total | Power | Maintenance | Total | Annual | Per truck |
| | | Dollars | Years | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars | Dollars |
| Dump pit..... | 2 | 12,000 | 25 | 480.00 | 330.00 | 240.00 | 1,050.00 | -- | -- | -- | 1,050.00 | 0.46 |
| Platform scale.. | 1 | 8,826 | 20 | 441.30 | 242.60 | 353.04 | 1,036.94 | 15.00 | 50.00 | 65.00 | 1,101.94 | .48 |
| Screw conveyor.. | 2 | 3,646 | 15 | 97.22 | 40.00 | 58.34 | 195.56 | 48.60 | 36.46 | 85.06 | 280.62 | .12 |
| Bucket elevator. | 2 | 7,344 | 20 | 367.20 | 202.00 | 293.76 | 862.96 | 48.60 | 73.44 | 122.04 | 985.00 | .43 |
| Cradle hoist[5]... | 2 | 2,888 | 15 | 192.54 | 79.40 | 115.52 | 387.46 | 21.60 | 28.88 | 50.48 | 437.94 | .19 |
| Platform hoist[6]. | 2 | 22,200 | 20 | 1,110.00 | 610.50 | 888.00 | 2,608.50 | 33.20 | 222.00 | 255.20 | 2,863.70 | 1.25 |
| Moisture meter.. | 1 | 465 | 10 | 46.50 | 12.78 | 18.60 | 77.88 | 4.50 | 4.65 | 9.15 | 87.03 | .04 |
| Truck hoist..... | 2 | 2,500 | 15 | 166.66 | 68.76 | 100.00 | 335.42 | 14.00 | 25.00 | 39.00 | 374.42 | .16 |
| Gram scale..... | 1 | 45 | 20 | 2.25 | 1.23 | 1.80 | 5.28 | -- | -- | -- | 5.28 | (7) |
| Weight per bushel equipment..... | 1 | 29 | 20 | 1.45 | .80 | 1.16 | 3.41 | -- | -- | -- | 3.41 | (7) |
| Trier..... | 2 | 63 | 20 | 3.15 | 1.73 | 2.52 | 7.40 | -- | -- | -- | 7.40 | (7) |
| Miscellaneous.... | -- | 100 | 1 | 100.00 | 5.50 | -- | 105.50 | -- | -- | -- | 105.50 | .05 |

[1] Same equipment is used in all methods of receiving except the truck hoist which is used only in improved methods of receiving.
[2] All figures given are f.o.b. factory, except those for dump pit and miscellaneous.
[3] Depreciation calculated on straight-line basis; interest at 5 1/2 percent of average investment; insurance and taxes at 4 percent; no insurance charged to dump pit.
[4] Power costs figured at the rate of 2 cents per kw.-hr.; maintenance at 1 percent of original investment, except platform scale which is on a standard maintenance contract.
[5] Shown only where cradle hoist was used in raising trucks for dumping.
[6] Shown only where platform hoist was used in raising trucks for dumping.
[7] Less than 1 cent.

## Labor Requirements

Table 7.--Labor requirements for various elements of work performed in receiving grain sorghum

| Time item | Base time | Fatigue and personal allowance[1] | Productive time |
|---|---|---|---|
| Testing and weighing operations | | | |
| Scale operator: | Minutes | Minutes | Man-minutes |
| Writes scale ticket for loaded truck | 0.65 | 0.07 | 0.72 |
| Weighs loaded truck | .18 | .02 | .20 |
| Prints weight on scale ticket | .04 | -- | .04 |
| Lays ticket aside | .07 | .01 | .08 |
| Locates ticket for empty truck and inserts it in scale | .10 | .01 | .11 |
| Weighs empty truck | .18 | .02 | .20 |
| Writes ticket for empty truck | .43 | .04 | .47 |
| Hands ticket to driver | .06 | .01 | .07 |
| Hands ticket to test-weight operator | .06 | .01 | .07 |
| Records and hands moisture ticket to driver | .11 | .01 | .12 |
| Test operator (moisture): | | | |
| Collects sample (3 probes) | [2] .35 | .05 | .40 |
| Transports sample (18 feet) | .12 | .01 | .13 |
| Weighs 150-gram sample | .35 | .04 | .39 |
| Pours sample into moisture tester | .11 | .01 | .12 |
| Tests sample for moisture | .11 | .01 | .12 |
| Reads moisture chart | .08 | .01 | .09 |
| Records moisture | .05 | -- | .05 |
| Writes log-book entry | .05 | .01 | .06 |
| Hands report to driver | .06 | .01 | .07 |
| Cleans moisture tester | .17 | .02 | .19 |
| Walks for sample (18 feet) | .12 | .01 | .13 |
| Hands report to test-weight operator | .04 | -- | .04 |
| Places ticket on scale operator's desk | .07 | .01 | .08 |
| Prepares report for driver (not scale ticket) | .05 | -- | .05 |
| Improved method: | | | |
| Determines moisture and reports to scale operator. | .24 | .02 | .26 |
| Walks to truck and hands moisture report or scale ticket to driver | .10 | .01 | .11 |
| Walks to scale-house window | .06 | .01 | .07 |
| Mounts dock to collect next sample | .05 | [2] .01 | .06 |
| Directs traffic | .11 | .01 | .12 |
| Test operator (test weight): | | | |
| Collects sample (3 probes) | .35 | [2] .05 | .40 |
| Transports sample (18 feet) | .12 | .01 | .13 |
| Fills test-weight cup | .04 | -- | .04 |
| Levels grain in cup | .07 | .01 | .08 |
| Determines test weight | .13 | .01 | .14 |

See footnotes at end of table.

Table 7.--Labor requirements for various elements of work performed in receiving grain sorghum--Continued

| Time item | Base time | Fatigue and personal allowance[1] | Productive time |
|---|---|---|---|
| Testing and weighing operations (continued) | | | |
| Test operator (test weight) (continued) | Minutes | Minutes | Man-minutes |
| Records test weight | 0.05 | -- | 0.05 |
| Empties test-weight cup | .04 | -- | .04 |
| Lays report aside | .04 | -- | .04 |
| Receives report from moisture test operator | .04 | -- | .04 |
| Hands report to driver | .06 | .01 | .07 |
| Prepares next report | .09 | .01 | .10 |
| Sampler: | | | |
| Walks for sample (125 feet) | .54 | .05 | .59 |
| Boards loaded truck | .10 | [2] .01 | .11 |
| Collects sample (3 probes) | .35 | [2] .05 | .40 |
| Dismounts from truck | .17 | [2] .02 | .19 |
| Numbers trucks and places number (slip) in sample container | .11 | .01 | .12 |
| Walks to next truck (25 feet) | .10 | .01 | .11 |
| Transports samples to scale house (150 feet) | .64 | .06 | .70 |
| Unloading operations | | | |
| For self-dump trucks: | | | |
| Receive moisture ticket and direct driver | .16 | .02 | .18 |
| For trucks raised with cradle hoist: | | | |
| Receive moisture ticket from driver | .15 | .02 | .17 |
| Operate hoist and direct positioning of truck over pit | .18 | .02 | .20 |
| Raise cradle | .71 | .07 | .78 |
| Lower cradle | .68 | .07 | .75 |
| Chock wheel | .09 | [2] .01 | .10 |
| Unchock wheel | .09 | [2] .01 | .10 |
| Walk to hoist control | .05 | -- | .05 |
| For trucks raised on platform hoist: | | | |
| Receive moisture ticket and turn on hoist motor | .16 | .02 | .18 |
| Raise backstop and direct driver | .15 | .02 | .17 |
| Raise platform | 1.09 | .11 | 1.20 |
| Turn off hoist motor | .09 | .01 | .10 |
| Lower platform | .88 | .09 | .97 |
| Lower backstop | .04 | -- | .04 |

See footnotes at end of table.

Table 7.--Labor requirements for various elements of work performed in receiving grain sorghum--Continued

| Time item | Base time | Fatigue and personal allowance[1] | Productive time |
|---|---|---|---|
| Unloading operations (continued) | | | |
| For trucks raised with single-cable hoist (improved method): | Minutes | Minutes | Man-minutes |
| Receive moisture ticket from driver and direct positioning | 0.16 | 0.02 | 0.18 |
| Operate hoist to set lift bar hook | .17 | .02 | .19 |
| Raise truck bed | .41 | .04 | .45 |
| Lower truck bed | .39 | .04 | .43 |
| Operate hoist to remove lift bar hook | .14 | .01 | .15 |
| Walk to lift bar and remove hook | .09 | .01 | .10 |
| Set lift bar hook | .17 | .02 | .19 |
| All types of trucks and hoists: | | | |
| Open tailgate (average for all types studied) | .25 | [3] .05 | .30 |
| Remove flap | .06 | [3] .01 | .07 |
| Assist with shoveling grain from trucks | .25 | [3] .05 | .30 |
| Assist with cleaning truck bed | .17 | [3] .03 | .20 |
| Replace flap | .08 | [3] .02 | .10 |
| Close tailgate (average for all types studied) | .25 | [3] .05 | .30 |
| Shovel grain from truck | .34 | [3] .07 | .41 |
| Clean truck bed | .41 | [3] .08 | .49 |
| Clean pit edges | .24 | [3] .05 | .29 |
| Walk to tailgate | .05 | -- | .05 |

[1] Fatigue and personal allowances are each 5 percent of base time unless otherwise noted.
[2] Fatigue allowance is 10 percent of base time.
[3] Fatigue allowance is 15 percent of base time.

# OBSERVED METHOD

## *Unloading Self-Dump Trucks*

## Single-Pit Layout, 2-Man Crew

| | DRIVER | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | RECEIVES MOISTURE TICKET AND DIRECTS DRIVER | 0.18 | WAITS | 0.18 |
| 0.20 | | | | | | |
| 0.30 | WAITS | 0.37 | WAITS | 1.18 | OPENS TAILGATE | 0.30 |
| 0.40 | | | | | | |
| 0.50 | | | | | REMOVES FLAP | 0.07 |
| 0.60 | | | | | | |
| 0.70 | RAISES TRUCK BED | 0.24 | | | WAITS | 0.70 |
| 0.80 | | | | | | |
| 0.90 | | | | | | |
| 1.00 | | | | | | |
| 1.10 | | | | | | |
| 1.20 | WAITS | 0.87 | | | | |
| 1.30 | | | | | | |
| 1.40 | | | | | | |
| 1.50 | | | ASSISTS WITH GRAIN SHOVELING | 0.30 | SHOVELS GRAIN | 0.41 |
| 1.60 | | | | | | |
| 1.70 | | | | | | |
| 1.80 | RAISES TRUCK BED | 0.15 | | | | |
| 1.90 | | | | | WAITS | 1.28 |
| 2.00 | | | | | | |
| 2.10 | | | | | | |
| 2.20 | | | | | | |
| 2.30 | | | | | | |
| 2.40 | | | | | | |
| 2.50 | | | | | | |
| 2.60 | | | WAITS | 1.86 | | |
| 2.70 | WAITS | 1.91 | | | | |
| 2.80 | | | | | | |
| 2.90 | | | | | | |
| 3.00 | | | | | | |
| 3.10 | | | | | CLEANS PIT EDGES | 0.29 |
| 3.20 | | | | | | |
| 3.30 | | | | | | |
| 3.40 | | | | | CLEANS TRUCK | 0.49 |
| 3.50 | | | | | | |
| 3.60 | | | ASSISTS IN CLEANING BED | 0.20 | | |
| 3.70 | | | | | | |
| 3.80 | LOWERS TRUCK BED | 0.17 | | | REPLACES FLAP | 0.10 |
| 3.90 | | | | | | |
| 4.00 | WAITS | 0.23 | WAITS | 0.52 | CLOSES TAILGATE | 0.30 |
| 4.10 | | | | | | |
| 4.20 | DRIVES AWAY | 0.12 | | | WAITS | 0.12 |

| | | | |
|---|---|---|---|
| PRODUCTIVE LABOR (MAN-MINUTES) | | 0.68 | 1.96 |
| UNPRODUCTIVE LABOR (MAN-MINUTES) | | 3.56 | 2.28 |
| TOTAL ELAPSED TIME (MINUTES) | 4.24 | | |

Figure 21

# OBSERVED METHOD

## *Unloading Self-Dump Trucks*

## Single-Pit Layout, 3-Man Crew

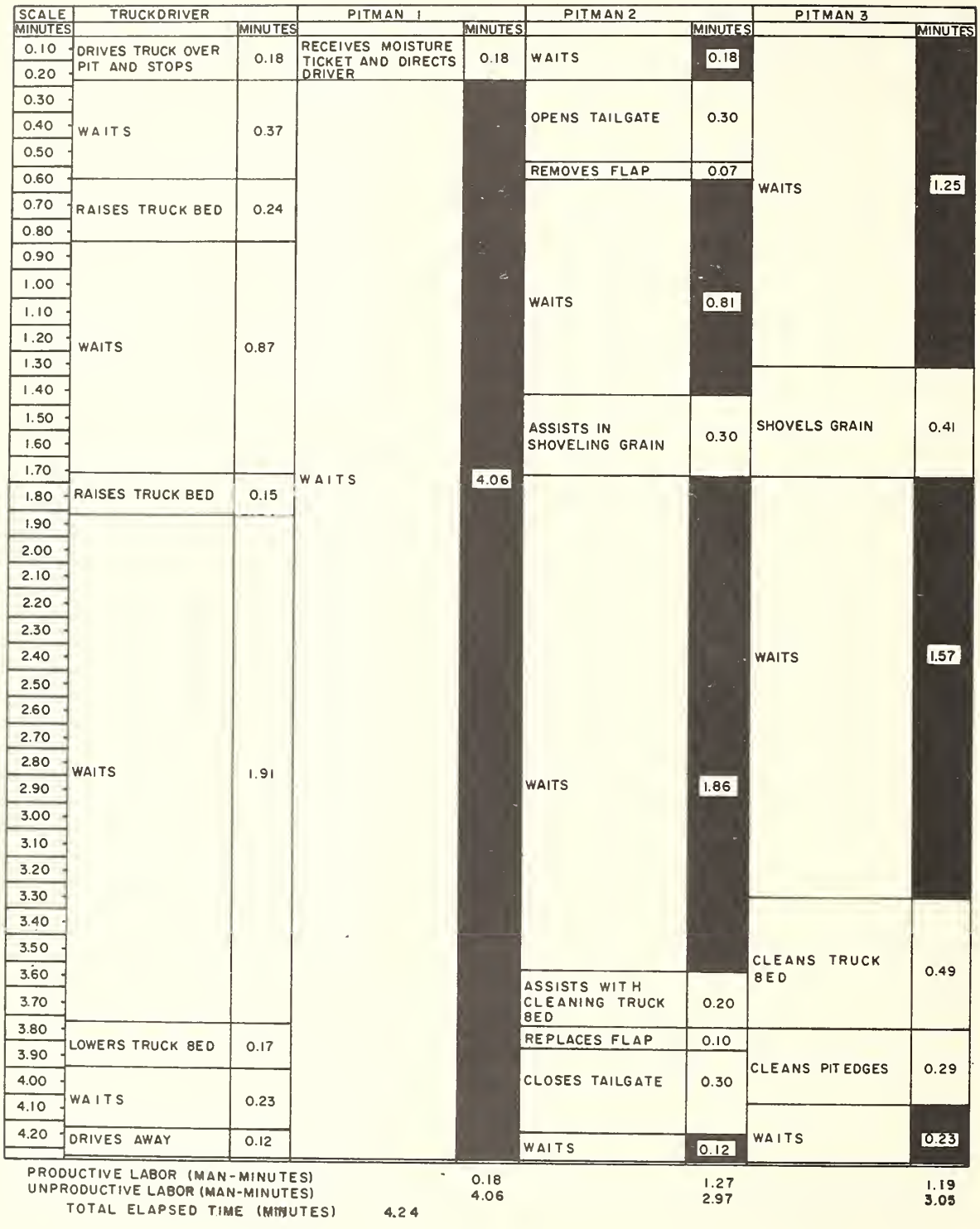


Figure 22

# OBSERVED METHOD

## *Unloading Self-Dump Trucks*

## Double-Pit Layout, 3-Man Crew

| | DRIVER A | MINUTES | DRIVER B | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES | PITMAN 3 | MINUTES |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | WAITS | 0.14 | RECEIVES MOISTURE TICKET AND DIRECTS DRIVER A | 0.18 | WAITS | 0.18 | CLOSES TAILGATE | 0.10 |
| 0.20 | | | DRIVES AWAY | 0.12 | WAITS | 0.07 | | | WAITS | 0.30 |
| 0.30 | WAITS | 0.37 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | RECEIVES MOISTURE TICKET AND DIRECTS DRIVER B | 0.18 | OPENS TAILGATE TRUCK A | 0.30 | | |
| 0.40 | | | | | | | | | | |
| 0.50 | | | | | | | REMOVES FLAP | 0.07 | OPENS TAILGATE TRUCK B | 0.30 |
| 0.60 | | | WAITS | 0.37 | | | | | | |
| 0.70 | RAISES TRUCK BED | 0.24 | | | | | | | REMOVES FLAP | 0.07 |
| 0.80 | | | | | WAITS | 0.93 | WAITS | 0.70 | | |
| 0.90 | | | | | | | | | | |
| 1.00 | | | RAISES TRUCK BED | 0.24 | | | | | | |
| 1.10 | | | | | | | | | WAITS | 0.80 |
| 1.20 | WAITS | 0.87 | | | | | | | | |
| 1.30 | | | | | | | | | | |
| 1.40 | | | | | | | | | | |
| 1.50 | | | WAITS | 0.97 | | | | | | |
| 1.60 | | | | | ASSISTS WITH SHOVELING GRAIN PIT A | 0.30 | SHOVELS GRAIN PIT A | 0.41 | | |
| 1.70 | | | | | | | | | | |
| 1.80 | RAISES TRUCK BED | 0.15 | | | WALKS TO TRUCK B | 0.05 | | | | |
| 1.90 | | | | | ASSISTS WITH SHOVELING GRAIN PIT B | 0.30 | | | SHOVELS GRAIN PIT B | 0.41 |
| 2.00 | | | | | | | | | | |
| 2.10 | | | RAISES TRUCK BED | 0.15 | | | | | | |
| 2.20 | | | | | | | | | | |
| 2.30 | | | | | | | WAITS | 1.28 | | |
| 2.40 | | | | | | | | | | |
| 2.50 | | | | | | | | | | |
| 2.60 | | | | | | | | | WAITS | 1.26 |
| 2.70 | | | | | WAITS | 1.51 | | | | |
| 2.80 | WAITS | 1.91 | | | | | | | | |
| 2.90 | | | | | | | | | | |
| 3.00 | | | | | | | | | | |
| 3.10 | | | WAITS | 1.81 | | | CLEANS EDGES PIT A | 0.29 | | |
| 3.20 | | | | | | | | | | |
| 3.30 | | | | | | | | | | |
| 3.40 | | | | | | | CLEANS TRUCK BED A | 0.49 | CLEANS EDGES PIT B | 0.29 |
| 3.50 | | | | | | | | | | |
| 3.60 | | | | | ASSISTS WITH CLEANING TRUCK BED A | 0.20 | | | | |
| 3.70 | | | | | | | | | CLEANS TRUCK BED B | 0.41 |
| 3.80 | LOWERS TRUCK BED | 0.17 | | | WALKS TO TRUCK B | 0.05 | REPLACES FLAP TRUCK A | 0.10 | | |
| 3.90 | | | | | ASSISTS WITH CLEANING TRUCK BED B | 0.20 | | | | |
| 4.00 | WAITS | 0.23 | | | | | CLOSES TAILGATE TRUCK A | 0.30 | REPLACES FLAP TRUCK B | 0.10 |
| 4.10 | | | LOWERS TRUCK BED | 0.17 | WAITS | 0.27 | | | CLOSES TAILGATE TRUCK B | 0.20 |
| 4.20 | DRIVES AWAY | 0.12 | WAITS | 0.09 | | | WAITS | 0.12 | | |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | | | 1.46 | | 1.96 | | 1.88 |
| | UN PRODUCTIVE LABOR (MAN-MINUTES) | | | | | 2.78 | | 2.28 | | 2.36 |
| | TOTAL ELAPSED TIME (MINUTES) | | | | 4.24 | | | | | |

Figure 23

# OBSERVED METHOD

*Unloading Trucks Using Platform Hoist*

**Single-Pit Layout, 2-Man Crew**

| | DRIVER | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES |
|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | TURNS ON HOIST MOTOR AND RECEIVES MOISTURE TICKET | 0.18 | WAITS | 0.18 |
| 0.20 | | | | | | |
| 0.30 | POSITIONS TRUCK | 0.17 | DIRECTS DRIVER | 0.17 | RAISES BACKSTOP | 0.17 |
| 0.40 | | | | | | |
| 0.50 | | | WAITS | 0.30 | OPENS TAILGATE | 0.30 |
| 0.60 | | | | | | |
| 0.70 | | | | | REMOVES FLAP | 0.07 |
| 0.80 | | | | | | |
| 0.90 | | | | | | |
| 1.00 | | | RAISES PLATFORM | 0.60 | WAITS | 0.53 |
| 1.10 | | | | | | |
| 1.20 | | | | | | |
| 1.30 | | | WALKS TO TRUCK | 0.05 | | |
| 1.40 | | | | | | |
| 1.50 | | | ASSISTS WITH GRAIN SHOVELING | 0.30 | SHOVELS GRAIN | 0.41 |
| 1.60 | | | | | | |
| 1.70 | | | WALKS TO HOIST CONTROL | 0.05 | | |
| 1.80 | | | | | | |
| 1.90 | | | | | | |
| 2.00 | | | RAISES PLATFORM | 0.60 | WAITS | 0.60 |
| 2.10 | | | | | | |
| 2.20 | WAITS | 3.47 | | | | |
| 2.30 | | | | | | |
| 2.40 | | | TURNS OFF HOIST MOTOR | 0.10 | | |
| 2.50 | | | WAITS | 0.15 | | |
| 2.60 | | | WALKS TO TRUCK | 0.05 | CLEANS TRUCK BED | 0.49 |
| 2.70 | | | | | | |
| 2.80 | | | ASSISTS IN CLEANING BED | 0.20 | | |
| 2.90 | | | TURNS ON HOIST MOTOR | 0.10 | | |
| 3.00 | | | | | CLEANS PIT EDGES | 0.29 |
| 3.10 | | | | | | |
| 3.20 | | | | | REPLACES FLAP | 0.10 |
| 3.30 | | | LOWERS PLATFORM | 0.97 | CLOSES TAILGATE | 0.30 |
| 3.40 | | | | | | |
| 3.50 | | | | | | |
| 3.60 | | | | | | |
| 3.70 | | | | | WAITS | 0.68 |
| 3.80 | | | | | | |
| 3.90 | | | TURNS OFF HOIST MOTOR | 0.10 | | |
| 4.00 | BOARDS TRUCK AND STARTS ENGINE | 0.30 | | | | |
| 4.10 | | | WAITS | 0.32 | | |
| 4.20 | | | | | LOWERS BACKSTOP | 0.04 |
| | DRIVES AWAY | 0.12 | | | WAITS | 0.08 |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | 3.47 | | 2.17 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | 0.77 | | 2.07 |
| | TOTAL ELAPSED TIME (MINUTES) | | 4.24 | | | |

Figure 24

# OBSERVED METHOD

## *Unloading Trucks Using Platform Hoist*

### Single-Pit Layout, 3-Man Crew

| SCALE MINUTES | TRUCKDRIVER | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES | PITMAN 3 | MINUTES |
|---|---|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.18 | RECEIVES MOISTURE TICKET AND TURNS ON HOIST MOTOR | 0.18 | WAITS | 0.18 | WAITS | 0.35 |
| 0.20 | | | | | | | | |
| 0.30 | POSITIONS TRUCK | 0.17 | DIRECTS DRIVER | 0.17 | RAISES BACKSTOP | 0.17 | | |
| 0.40 | | | | | | | | |
| 0.50 | | | WAITS | 0.32 | WAITS | 0.30 | OPENS TAILGATE | 0.30 |
| 0.60 | | | | | | | | |
| 0.70 | | | | | REMOVES FLAP | 0.07 | | |
| 0.80 | | | | | | | | |
| 0.90 | | | RAISES PLATFORM | 0.60 | | | | |
| 1.00 | | | | | WAITS | 0.74 | WAITS | 0.62 |
| 1.10 | | | | | | | | |
| 1.20 | | | | | | | | |
| 1.30 | | | | | | | | |
| 1.40 | | | WAITS | 0.49 | | | | |
| 1.50 | | | | | | | | |
| 1.60 | | | | | ASSISTS WITH SHOVELING GRAIN | 0.30 | SHOVELS GRAIN | 0.49 |
| 1.70 | | | | | | | | |
| 1.80 | | | | | | | | |
| 1.90 | | | RAISES PLATFORM | 0.60 | | | | |
| 2.00 | | | | | | | | |
| 2.10 | | | | | | | WAITS | 0.60 |
| 2.20 | | | | | WAITS | 0.89 | | |
| 2.30 | WAITS | 3.47 | | | | | | |
| 2.40 | | | TURNS OFF HOIST MOTOR | 0.10 | | | | |
| 2.50 | | | | | | | | |
| 2.60 | | | WAITS | 0.29 | | | | |
| 2.70 | | | | | | | CLEANS TRUCK BED | 0.49 |
| 2.80 | | | | | ASSISTS WITH CLEANING TRUCK BED | 0.20 | | |
| 2.90 | | | TURNS ON HOIST MOTOR | 0.10 | | | | |
| 3.00 | | | | | REPLACES FLAP | 0.10 | | |
| 3.10 | | | | | | | CLEANS PIT EDGES | 0.29 |
| 3.20 | | | | | CLOSES TAILGATE | 0.30 | | |
| 3.30 | | | LOWERS PLATFORM | 0.97 | | | | |
| 3.40 | | | | | | | | |
| 3.50 | | | | | | | | |
| 3.60 | | | | | | | | |
| 3.70 | | | | | | | WAITS | 1.10 |
| 3.80 | | | | | WAITS | 0.99 | | |
| 3.90 | | | TURNS OFF HOIST MOTOR | 0.10 | | | | |
| 4.00 | BOARDS TRUCK AND STARTS ENGINE | 0.30 | | | | | | |
| 4.10 | | | WAITS | 0.20 | | | | |
| 4.20 | DRIVES AWAY | 0.12 | LOWERS BACKSTOP | 0.04 | | | | |
| | | | WAITS | 0.08 | | | | |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | 2.86 | | 1.14 | | 1.57 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | 1.38 | | 3.10 | | 2.67 |
| | TOTAL ELAPSED TIME (MINUTES) 4.24 | | | | | | | |

Figure 25

# OBSERVED METHOD

## *Unloading Trucks Using Cradle Hoists*

## Double-Pit Layout, 3-Man Crew

| | DRIVER A | MINUTES | DRIVER B | MINUTES | PITMAN 1 | MINUTES | PITMAN 2 | MINUTES | PITMAN 3 | MINUTES |
|---|---|---|---|---|---|---|---|---|---|---|
| 0.10 | DRIVES TRUCK OVER PIT AND STOPS | 0.17 | BOARDS TRUCK AND STARTS ENGINE | 0.10 | RECEIVES MOISTURE TICKET FROM DRIVER A | 0.17 | WAITS | 0.37 | WAITS | 0.57 |
| 0.20 | | | DRIVES AWAY | 0.12 | OPERATES HOIST AND DIRECTS DRIVER A | 0.20 | | | | |
| 0.30 | POSITIONS TRUCK | 0.20 | DRIVES TRUCK OVER PIT AND STOPS | 0.17 | OPERATES HOIST AND DIRECTS DRIVER B | 0.20 | OPENS TAILGATE TRUCK A | 0.30 | OPENS TAILGATE TRUCK B | 0.30 |
| 0.40 | | | | | | | | | | |
| 0.50 | | | POSITIONS TRUCK | 0.20 | CHOCKS TRUCKS A AND B | 0.20 | REMOVES FLAP | 0.07 | REMOVES FLAP | 0.07 |
| 0.60 | | | | | | | | | | |
| 0.70 | | | | | | | | | | |
| 0.80 | | | | | RAISES TRUCKS A AND B | 0.48 | | | | |
| 0.90 | | | | | | | | | | |
| 1.00 | | | | | | | | | | |
| 1.10 | | | | | | | WAITS | 1.13 | WAITS | 1.13 |
| 1.20 | | | | | | | | | | |
| 1.30 | | | | | | | | | | |
| 1.40 | | | | | WAITS | 0.86 | | | | |
| 1.50 | | | | | | | | | | |
| 1.60 | | | | | | | | | | |
| 1.70 | | | | | | | | | | |
| 1.80 | | | | | | | | | | |
| 1.90 | WAITS | 3.45 | | | | | SHOVELS GRAIN PIT A | 0.41 | SHOVELS GRAIN PIT B | 0.41 |
| 2.00 | | | | | | | | | | |
| 2.10 | | | | | | | | | | |
| 2.20 | | | | | RAISES TRUCKS A AND B | 0.67 | WAITS | 0.30 | WAITS | 0.30 |
| 2.30 | | | | | | | | | | |
| 2.40 | | | | | | | | | | |
| 2.50 | | | WAITS | 3.45 | | | | | | |
| 2.60 | | | | | WAITS | 0.12 | CLEANS TRUCK BED A | 0.49 | CLEANS TRUCK BED B | 0.49 |
| 2.70 | | | | | | | | | | |
| 2.80 | | | | | | | | | | |
| 2.90 | | | | | | | REPLACES FLAP TRUCK A | 0.10 | REPLACES FLAP TRUCK B | 0.10 |
| 3.00 | | | | | LOWERS TRUCKS A AND B | 0.95 | CLOSES TAILGATE TRUCK A | 0.30 | CLOSES TAILGATE TRUCK B | 0.30 |
| 3.10 | | | | | | | | | | |
| 3.20 | | | | | | | CLEANS EDGES PIT A | 0.29 | CLEANS EDGES PIT B | 0.29 |
| 3.30 | | | | | | | | | | |
| 3.40 | | | | | | | | | | |
| 3.50 | | | | | | | | | | |
| 3.60 | | | | | | | | | | |
| 3.70 | | | | | | | | | | |
| 3.80 | | | | | | | | | | |
| 3.90 | BOARDS TRUCK AND STARTS ENGINE | 0.30 | | | REMOVES CHOCKS FROM TRUCKS A AND B | 0.22 | WAITS | 0.48 | WAITS | 0.28 |
| 4.00 | | | | | | | | | | |
| 4.10 | | | BOARDS TRUCK AND STARTS ENGINE | 0.20 | | | | | | |
| 4.20 | DRIVES AWAY | 0.12 | | | WAITS | 0.17 | | | | |
| | PRODUCTIVE LABOR (MAN-MINUTES) | | | | | 3.09 | | 1.96 | | 1.96 |
| | UNPRODUCTIVE LABOR (MAN-MINUTES) | | | | | 1.15 | | 2.28 | | 2.28 |
| | TOTAL ELAPSED TIME (MINUTES) | | | | | 4.24 | | | | |

Figure 26



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